2006

The Effects Of Inquiry And Single-gender Grouping On Second Grade Girls' Attitudes And Participation In Science

Elsy Estrada
University of Central Florida

THE EFFECTS OF INQUIRY AND SINGLE-GENDER GROUPING ON SECOND GRADE GIRLS' ATTITUDES AND PARTICIPATION IN SCIENCE

by

ELSY ESTRADA
B.A. Rutgers University, 1993

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Education
in the Department of Teaching and Learning Principles
in the College of Education
at the University of Central Florida
Orlando, Florida

Spring Term
2006

ABSTRACT

Disparities between males and females in attitudes toward science have been the focus of extensive investigations. Studies have found that females feel intimidated by their male peers in science and mathematics classes, making girls less likely to participate. Their confidence in these areas decreases and they become less likely to follow related career paths. Researchers and educators are at task to find methods to provide equal learning opportunities for all students. The purpose of this action research was to investigate the effects of single-gender grouping and inquiry-based teaching on girls' participation and attitude in science class. This study took place in a second grade classroom at a suburban school in the fall of 2005. Surveys and interviews were used to investigate students' attitudes before and after working with inquiry learning single-gender groups. Using observations, female students' participation was recorded according to the kind of participation they exhibited – passive/assisting, active/leading, or active/manipulating. Students maintained journals to record their understanding of science content and rated the lessons. In addition to improving female students' attitudes towards science, inquiry learning fostered an increase in active student participation. Six out of the eight female students perceived that girls participated more in single-gender groups during the study than they did before the study in their regular mixed-gender groups. However, they did not report a change in their own participation in relation to their peers after working in single-gender groups. Further research with control groups was suggested with a larger and more socio-economically diverse population.

ACKNOWLEDGMENTS

I would like to thank all my students because they were my source of inspiration for this study. I would like to express my sincere appreciation to all the professors at the University of Central Florida who helped me become a better teacher, especially to my advisor Dr. Jeanpierre, who guided me through the process. To my sisters who always provided words of encouragement. Finally, to Mom and Dad who gave me their support.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

Purpose of the Study

In my experience of teaching second and third grades, I have witnessed female students taking supporting roles in group work while male students take more leading roles. My belief is that providing girls opportunities to explore science in a setting where they feel freedom of expression will encourage their interest in the subject. The purpose of this action research was to examine female students' participation and attitude towards science through the use of inquiry-based learning and single-gender grouping. Quantitative and qualitative data were examined to investigate the effects of inquiry learning and single-gender grouping on girls' attitudes and participation.

Research Question #1

What was female students' attitude towards science during inquiry lessons?

Research Question #2

How did female students participate in science class during inquiry lessons?

Research Question #3

What was female students' perception of their participation in single-gender groups?

Rationale for the Study

Research shows that female students have similar aspirations and plans to those of male students before entering high school, but they continue to select majors and careers traditionally held by women after graduation (Post & Williams, 1996; Stocking & Goldstein, 1992). Careers traditionally adopted by women are those in the social services field, as opposed to those typically dominated by males, which include those related to math, science, and engineering. Further research is needed to find out what experiences girls undergo during their education years to yield such a disparity in final career decisions between males and females.

Cultural issues related to gender may play a part in the inequity for girls in the fields of mathematics and science. Gender involves social processes by which people are regarded and regard themselves differently. For example, there are behaviors, such as assertiveness, that are socially expected of boys but are not viewed as acceptable of girls. Studies have found that female students' learning in mathematics and science may be affected by gender-biased treatment and expectations set for them at home, in the community, and in the classrooms (AAUW, 1992; El-Haj, 2003; Post & Williams, 1996; Tocci & Engelhard, 1991).

Existing evidence supports that females do not thrive in competitive atmospheres with conventional teaching methods (Becker & Miles, 1978; El-Haj, 2003; Hammrich, 2002; Richardson, Hammrich, & Livingston, 2003; Strand & Mayfield, 2002). Strand and Mayfield (2002) found that "more effective teaching for girls uses experiential and "discovery-based" learning" (p.68) such as inquiry. Educators need to find more effective accommodations to ensure equality in education for girls.

According to a study by the American Association of University Women (1992), 75% of girls in elementary school like science but by high school, the percentage decreases to only 63%. The AAUW recommends the inclusion of different teaching techniques, as opposed to traditional teaching methods, in the classroom to improve girls' attitudes towards science (American Association of University Women, 1992). "The learning style of girls does not align itself with the practice of science" (Hammrich, 2002, p. 84). Science is practiced and taught in an individualist and competitive environment, while females tend to learn better in an environment of cooperation and connectedness to the real world (El-Haj, 2003, p. 411).

The National Science Education Standards (1996) encourage use of inquiry in the classroom to allow students to formulate questions, plan and carryout investigations, and analyze and share their finding with others. The goal is to make students active participants in science by giving them choices and an opportunity to make their learning meaningful. The idea behind inquiry-based learning is that children learn better by making sense of the world through exploration, as Dewey (1916) describes it in his constructivist approach to the subject, "Science represents the fruition of the cognitive factors in experience" (p. 229). The role of the teacher and the level of engagement of the students are important parts of inquiry learning (NRC, 2000).

Significance of the Study

Research indicates that female students in middle school report feeling intimidated by the presence of boys in their classes or learning teams, and consequently, they feel that their group participation becomes restricted (Streitmatter, 1997; Campbell & Evans, 1997). The ability to interact and communicate with peers is an important aspect of any student's inquiry learning experience. Intimidation needs to be studied as a possible factor that causes girls to exit the competition in male-dominated fields. An important aspect to look at is whether the career aspiration changes that girls show at the end of high school is a result of the 4 year experience or of a product of an accumulation of experiences during their entire academic life.

"Many students in science classrooms are members of marginalized or oppressed groups" (Atwater, 1996, p. 823). Atwater suggests that women and minorities develop ways of adapting to oppression by accommodation, silence, and evasiveness (p. 823). Thus, she encourages further research in the education of oppressed groups to find ways to include all students equally in constructive learning (p. 832). This research examined single-gender grouping in a co-educational classroom as an option for providing female students with greater opportunity to participate in the inquiry learning experience.

Definitions

Attitudes – Student attitudes towards science were investigated using surveys and interviews. The term attitude includes a wide range of affective behaviors (e.g., prefer, accept, appreciate, and commit) and defines our favorable or unfavorable feelings toward something (Kobella, 1989).

Active-manipulating behaviors –Active-manipulating behaviors occurred when a student had active control of the science equipment, recorded written information for the group, or read directions to the group, without also engaging in assisting-type behaviors (Dreves and Jovanovic, 1998).

Active-leading behaviors – Active-leading behaviors included the performance behaviors that demonstrated active leadership in the group such as directing, suggesting, and explaining (Dreves and Jovanovic, 1998).

Constructivism – Constructivism is a theory that explains the nature of human knowledge. Constructivists support that learning begins from the inside of the child and knowledge is constructed through direct experience (Kamii & Ewing, 1996).

Discrepant event – "A scientific discrepant event is a phenomenon that occurs in a way that seems to run contrary to initial reasoning" (Wright & Govindarajan, 1995).

Inquiry-based learning – Inquiry-based learning refers to activities which help build an understanding of scientific ideas through direct experience. Inquiry "involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating results" (NRC, 1996, p. 23).

Journals – The journals were tools used by participating students to write their experimental plans and observations. Each page of the journal followed the format on Appendix B.

Passive-assisting behaviors – Passive-assisting behaviors include following other students' directions, assisting another student with manipulation, observing other students manipulating the material/equipment (Dreves and Jovanovic, 1998).

Summary

In this action research, I examined girls' participation and attitude towards science with inquiry and single-gender grouping to see if this learning style and setting engaged them actively in science learning. Surveys, interviews, journals, and observations were used to gather data and analyze the effects of single-gender grouping and inquiry learning on girls.

A review of existing studies and literature on the topic was presented in the next chapter. Chapter Three included the methods of data collection and analysis used in the research. Chapter Four presented the results and analysis. Conclusions and recommendations were discussed in Chapter Five.

CHAPTER TWO: LITERATURE REVIEW

Introduction

Research suggests that inquiry engages students in meaningful experiences that have a positive effect in student learning (Palincsar, Collins, Marano, & Magnusson, 2000; Schmidt, Gillen, Zollo, & Stone, 2002; Tamir, Stavy, & Ratner, 1998; Zuckerman & Chudinova, 1998). All students can have the opportunity to actively enhance their understanding of subject matter through discovery and inquiry. One crucial aspect for engaging in systematic inquiry is for students to solve problems in cooperation with peers (Zuckerman, Chudinova, & Khavkin, 1998). However, females report feeling intimidated by the presence of boys in their classes or learning teams, and consequently, they feel that their group participation becomes restricted (Campbell & Evans, 1997; Streitmatter, 1997). This review presents the problem through a summary of existing literature on girls' participation and attitudes towards science, and girls' choices of academic subjects and careers, followed by a summary of existing literature on the alternatives to close the gender gap in science, inquiry-based learning and single-gender accommodations. The objective was to find ways to address the needs of girls in science in order to provide them equitable opportunities for achievement and participation in an inquiry science classroom couched in a constructivist ideology.

Constructivism

Constructivism is a theory that explains the nature of human knowledge. Piaget, who is considered a proponent constructivism, proposes that learning begins from the inside of the child (Kamii & Ewing, 1996). “Knowledge is actively constructed by the learner, not passively from the environment; [and] coming know is a process of adaptation based on and constantly modified by a learner’s experience of the world” (Jaworski, 1996, p. 1).

The constructivist classroom allows learners to construct meaning in authentic contexts, and allows individual exploration, mainly on topics of personal interest to the student (Green & Gredler, 2002). “Students tend to make sense of experience by focusing on what they care about, embedding [academic] standards in…guided experiences naturally motivates students to ask questions that are personally important to them and that meet the standards at the same time” (Caine, Caine, & McClintic, 2002, p. p. 70). Constructivists value the importance of construction of meaning through dialogue as a key component (Green & Gredler, 2002). Constructivists emphasize the need for active participation by the learner and recognize the social nature of learning (Phillips, 1995).

“Inquiry learning and teaching is based on the constructivist approach, which perceives children as little scientists who experiment, solve problems, and discover how the world functions. Children become active classroom participants who connect with their own environments and formulate high-level questions” (Schmidt, Gillen, Zollo, & Stone, 2002, p. 534).

Girls' Participation and Attitudes towards Science

<u>The Elementary Years</u>

In a study of science attitudes, researchers found that fourth to fifth grade "girls became expressive and empowered to do science" when they "had the opportunities to work with other girls on relevant, inquiry-based projects without the threat of competition" from boys (Richardson, Hammrich & Livingston, 2003, p. 344). According to Strand and Mayfield (1997), boys and girls have different styles of learning, and more effective teaching for girls includes discovery-based learning, collaborative work in groups, and emphasis on cooperation over competition. Consistently, Becker and Miles (1978) found that females are less likely than males to choose to compete than to cooperate, and females are more likely to choose to cooperate with another female than with a male.

In a study to evaluate students' attitudes towards inquiry learning in elementary classrooms, Kelly (1999) concluded that boys and girls' ratings of mathematics and science studies were alike. Both genders evaluated inquiry similarly, and the perceptions of both genders were also comparable concerning the equal ability of males and females to become scientists (Kelly, 1999). Nevertheless, inquiry learning does not necessarily have a positive effect on female students throughout the post-elementary educational years of female students. The effect of inquiry is sensitive to social context differences, achievement gaps can grow if considerations are not taken to accommodate the needs of all students (Von Secker, 2002).

Although much of the existing research in gender differences involves students in fourth grade and above, educational professionals may have to begin looking at the participation of girls in science at earlier ages. “The reform of preK-12 education…has failed to adequately prepare students—especially women, underrepresented minorities, and persons with disabilities—in science, mathematics, and technology. Attention to the education of citizens must begin as early as the preschool years (0-4 years), when the learning process begins” (NSF, 2000, p. 15). My action research explored inquiry in single-gender groups in my second grade classroom as possibly effective way to prepare and motivate them to follow the careers of their choice in the future.

Girls’ Participation and Attitudes in the Middle School and High School Years

“Interactions with other persons provide individuals with information, in the form of attitudes, beliefs, and behaviors of relevant others, that becomes a guide for the development of their own attitudes” (Tocci & Engelhard, 1991, p. 280). In a one year study of fifth through eighth graders, Dreves and Jovanovic (1998) found that students who manipulated the science equipment more often, had better attitudes toward the subject at the end of the school year than students who manipulated the tools less often. Male students in their study were observed to have handled the equipment more than the girls, relegating the girls to only making suggestions or reading directions. Girls rated their abilities in science lower by the end of the year than at the beginning, even though their grades were similar to those of their male classmates. Girls react to the boys’ attempts to dominate by gradually adapting passively because “students’ cultural realities, including concepts of self and social roles, are constructed through social interactions” (Atwater, 1996, p. 828). “From a developmental perspective, children learn to be engendered through gender socialization” (Spencer, Porche, & Tolman, 2003, p. 1777).

The presence of boys in coeducational classes has an intimidating effect on girls and, as a result, girls’ attitudes and motivation suffer. In a study of a single-gender math class in a coeducational middle school, Campbell and Evans (1997) found that “mathematics anxiety among females in a single-sex class decreased, while mathematics anxiety among females in a coed class increased.” They concluded that “the females in the single-sex class will be more likely to enroll in advanced math classes in high school, thus keeping open the window of opportunity to higher paying, more prestigious careers in the future” (Campbell & Evans, 1997, p. 336).

Streitmatter (1997) conducted a study similar to that of Campbell and Evans (1997) at a co-ed high school running a pilot program including a female-only math class. During the interviews, students stated that they felt threatened by the negative comments of male students in the co-ed classes. Conversely, when asked about their feelings about the female-only class, girls reported feeling more relaxed because “nobody worried about anyone, especially a boy, telling [them they] couldn’t do it, or telling [them] to shut up when [they] wanted to ask a question” (Streitmatter, 1997, p. 24). It was found that girls “were more likely to ask and answer questions about subject matter in the math class than they were in their other classes, which were coeducational” (p. 15). Furthermore, “the girls-only class increased their confidence in their mathematics ability and their willingness to ask and answer questions during class” (p. 25). The females’ increased eagerness to ask questions in single-gender classrooms suggests that girls would be more active participants in inquiry learning in single-gender settings. During the research interviews, it was found that “in the girls-only class, there were no self-proclaimed experts. During the interviews, no girl indicated that the teacher favored anyone in the class or that any student performed better than any other or dominated the class in any way” (p. 23).

In an effort to improve discipline and improve girls’ achievement in math and science, the principal of a low-performing middle school in New Jersey, with the support of the community, separated boys and girls into single-gender classes (Richardson, 1995). One student in such study reported that in single-gender classes, “lots of girls [were] doing better and trying harder” (p. 15).

Contradictory evidence exists in studies where no differences in perception of mathematics and science education were found between boys and girls. Tocci and Engelhard’s (1991) study of 13 year old students found that “females believe more strongly than males do that studying mathematics is as appropriate for girls as it is for their male peers” (p. 284). Spencer, Porche and Tolman (2003) reported that seventh grade female students and their teachers found educational opportunity to be equitable in their co-ed school, even though the researchers identified gender-biased behaviors in the classroom during the study observations (p. 1801).

Girls’ Choices of Academic Subjects and Careers

“Although the ability and basic academic background needed to continue in [science, engineering and technology (SET)] careers exist for many girls, their interest in these careers is not maintained…By eighth grade, twice as many boys as girls (independent of race/ethnicity) show an interest in SET careers." (National Science Foundation, 2000, p. 16-17).

A study conducted in an urban school system, found that eighth grade "girls expect to take more math classes in high school, select careers that require a college education, and plan to go to college more frequently than do boys" (Post & Williams, 1996, p. 250), contradicting the National Science Foundation's (NSF) publication (2000). However, it was consistent with the NSF's report (2000) in that, when the time came to select careers, female participants significantly chose careers that are considered traditionally female more than mathematics and science related careers (p. 254). Post and Williams concluded that the perceived barriers of gender role orientation issues, confidence in mathematics and science, and competence seem to impede the fulfillment by women of their earlier career aspirations.

When it comes to competence, however, Stocking and Goldstein (1992) found that there was no significant difference between seventh grade boys and girls' math and science SAT scores . Also, the NSF (2000) reported that "by eighth grade, girls' interest in mathematics and confidence in their mathematics abilities have eroded, even though they perform as well as boys in this subject" (p.17). Thus, in this paper, competence is not considered as an impediment for choosing academic subjects and careers in math and science.

The factors that affect female students' confidence and gender role orientation issues, as they affect girls' career choices are worth further study. Also, investigations need to be targeted to find teaching strategies to allow females to maintain the motivation for pursuing careers in math and science that they exhibit during the elementary school years

Inquiry and Closing the Gender Gap in Science

All students, at any educational grade, can reap the benefits of inquiry or discovery learning. Discovery-based learning, collaborative work in groups, and emphasis on cooperation over competition are more effective teaching methods for girls' learning styles (Strand & Mayfield, 2002). Girls' resilience in science is diminished by traditional science teaching methods which include competition and individualism (AAUW, 1992).

Inquiry allows students to connect science to their world instead of performing procedures that are meaningless to them. "Traditionally, science teachers taught science the way they were taught. They used cookbook laboratory approach, where specific steps and expected answers were predetermined and students followed the directions as set forth in the laboratory manuals to derive the desired conclusion" (Jeanpierre, 2003, p. 7). With inquiry-learning, on the other hand, students are encouraged to work cooperatively and construct their own knowledge, investigating their own question (stimulus) for achieving connection with what they learn. According to Keegan (1993), "when the learner generates both stimulus and response, the instructional moment is one of discovery method, as in an interactive laboratory environment" (p. 18).

The National Science Education Standards (1996) focus on and support the use of inquiry. Classrooms are successful when inquiry is used because it allows students to formulate questions and devise ways to answer them, collect data and decide how to represent it, organize data to generate knowledge, and explain and justify their work to themselves and to one another. "They acquire knowledge, skills, and habits of mind that will enable them to come to deep understanding of the big ideas in science and to become facile with the process of engaging in scientific reasoning" (Palincsar, Collins, Marano, & Magnusson, 2000, p. 241).

Inquiry is characterized as a tool to connect the learner to real world experiences and promote higher-order thinking skills (Kelly, 1999). In a study of elementary children in first through fourth grade, Zuckerman, Chudinova and Khavkin (1998) found that inquiry methods contributed to children's ability to discern processes and transformations while traditional teaching methods did not.

Klahr and Nigam (2004) found evidence contradicting the benefits of inquiry in their research with third and fourth grade students. They reported that students performed better on science assessment after experiencing direct instruction than after learning through inquiry-based methods. No difference in ability was found between students who received direct instruction and those who participated in discovery learning.

Von Secker (2002) analyzed the effects of using inquiry-based teaching methods in science with tenth graders using data in the 1989-1990 National Education Longitudinal Study sponsored by the National Center for Education Statistics. He found evidence to support that higher achievement can be obtained through this practice. However, he also concluded that "the effect of inquiry-based teaching is sensitive to social context differences, and these practices are as likely to exacerbate achievement gaps among some groups of students as they are to narrow them among others" (p.159). Educators must make accommodations in the classroom to provide conditions for all students to be equal participants in the inquiry learning process. "If performance-based science classrooms are to succeed in promoting positive attitudes toward science among both girls and boys, these classrooms will have to provide opportunities for *all* students to perform science." (Jovanovic & King, 1998, p. 479).

Further research is needed to investigate ways of facilitating inquiry learning to nurture motivation in female students to pursue careers in math and science. The present study attempted to examine the participation of second grade female students in single-gender groups in a co-educational classroom during inquiry-oriented science classes.

Conclusion

Elementary school female students perceive themselves equally capable and willing to be scientists and mathematicians as boys. Nevertheless, their confidence and self-perceptions in the male-dominated subjects decline during the middle and high school years. Their perception of math and science as fields appropriate for women deteriorates. Intimidation by male students plays a role in females' attitudes toward taking classes in math and science and pursuing careers in related fields. We need to take a look at whether the intimidation from participation begins as early as the elementary grades and comes into girls' perceptions only later in their educational years.

Research supports that girls' participation in the science classroom may be decreased by the presence of boys, and that participation and manipulation of materials in class are correlated to better performance. Arranging students in coeducational classrooms into single-gender groups would give girls the opportunity to participate equally in hands-on activities and the freedom to ask questions and offer opinions without intimidation in their group. Using single-gender grouping with inquiry in coeducational classes is worth investigating as an option for schools where classrooms can rarely be separated by gender.

When students are able to ask questions and express their thoughts through inquiry, they reach higher levels of thinking. Single-gender grouping would provide equal quality in the inquiry experience for females, where they would no longer become passive, but involved participants. Thus, inquiry would serve its purpose of promoting a life-long desire for learning in women, allowing them to undertake careers in mathematics and science (Kelly, 1999).

The preceding review of literature indicated that it is important for teachers to provide girls with meaningful instruction and equitable learning opportunities in the classroom. In the next chapter, I discussed the methods of data collection and analysis used in this action research study.

CHAPTER THREE: METHODOLOGY

Problem and Rationale

The purpose of this action research was to examine inquiry learning and single-gender grouping in a coeducational classroom for ways to better engage my female students in science. I used surveys, interviews, journals, and observations to gather data and analyzed the effects of single-gender grouping and inquiry learning on girls' participation and attitude toward science. Data were collected over a period of four weeks on eight participating female students.

Design of the Study

"Action research is systematic inquiry done by teachers (or other individuals in the teaching/learning environment) to gather information about – and subsequently improve – how their particular schools operate, how they teach, and how well their students learn" (Mills, 2003). Using this mode of research allowed me to observe how my students learn science through participation. This study followed the steps in the action research process: identify an area of focus, collect data, analyze and interpret the data, and develop an action plan based on the observations for future use in the classroom.

I used both qualitative and quantitative data collection for my action research. The data were focused on female students' participation and attitudes towards science class using inquiry learning and single-gender grouping. The qualitative data included student interviews, observations, and journals. The quantitative data included pre and post attitude survey scores and observation scores of students' participation in class.

Setting

The elementary school where the study took place is located in a suburban community in the central Florida area with a reduced and free lunch percentage of 14. Students attend Kindergarten through fifth grade classes. The school has earned three Little Red House Awards, Five Star School Awards every year since 1994, and a grade of "A" every year since the 1998-1999 school year. The school serves 1,005 students of which 69.95% are Caucasian, 4.97% are African-American, 8.85% are Hispanic, and 15.23% are Asian, and 1% are multiracial.

My second grade class is self-contained and includes 15 students (60% girls: mean age= 7.5; 44% Caucasian, 33% Asian, 22% Hispanic; and 40% boys: mean age= 7.6; 33% Caucasian, 33% Hispanic, and 33% Hispanic). There are three ESOL students in the classroom. I used 8 out of the 9 female students in the class as participants. One girl had no parental permission for videotaping. Of the 8 girls participating in the observations, 2 are Hispanic, 2 are Asian, and 4 are Caucasian. Both Asian participants are ESOL students.

Data Collection Procedures

<u>Permissions</u>

Prior to the beginning of this action research, I obtained permission from the University of Central Florida Institutional Review Board (IRB) (Appendix E). I obtained permission from Heinnemann publishers to use the science attitude survey and the science discovery log published in the book Nurturing Inquiry by Charles Pearce (1999) (Appendix G). Permission was granted by Jasna Jovanovic to modify and use the observation measures in her 1998 study cited in this paper (Appendix F). Permission for the study was requested and granted by the principal of the school (Appendix H). Parental consent was obtained for each student in the class for participation, video taping, and audio taping with exception of one student who was not allowed participation for video taping. Permission notes are included in Appendix I. Once I had obtained all the fore-mentioned authorizations, I also obtained permission from the students. I read the student assent script (Appendix J) aloud to the students. Each student agreed to participate verbally and signed a copy of the student assent form. Pseudonym names were used in this study to maintain student confidentiality.

Classroom Arrangements

Science classes took place two times per week for forty-five minute periods during the four week duration of the study. The class was divided into three groups of four students and one group of three students during the study. The two groups I collected data on were made up of 4 participating females each. For non-participating students, one group contained 4 males; and the remaining group was composed of two boys and one girl. Observation data were not gathered on one girl in the class because she did not have parental permission for video-taping. Purposive selection was used so that students were distributed according to their overall academic achievement. Each group had two high achievers (Grades A in report cards), one student confident at grade level (grades B in report card), and one student struggling at grade level (grades C and D in report card). The previously described grouping was used only for science class during the study. During other times during the school day, students sat with the mixed gender groups they were assigned to at the beginning of the year.

Inquiry Instruction

The class had been learning science using traditional teaching methods and the district's adopted textbook before the study. For the study, I developed and presented inquiry science lessons on the states of matter following the objectives in the Sunshine State Standards and the Orange County Public Schools Science Curriculum. Hands-on materials and scientific tools were made available according to each specific lesson.

Class procedures for team work were established before the study began as follows: 1) Listen to and follow directions 2) Work safely 3) Take turns 4) Participate in work and discussions 5) Work together to finish your work on time.

A Typical Lesson

The experiments for the study were centered on the theme of properties of matter. I introduced each lesson with a discrepant event. For example, for a lesson where the objective was to learn that air takes up space, I placed a paper towel at the bottom of a cup, inverted the cup, and submerged it into a container filled with water. The students observed that the paper towel did not get wet and were intrigued by this phenomenon. Students worked in cooperative groups to duplicate what I presented. We followed with a brief discussion about the concept behind it. In this case, we discussed that air takes up space and did not let the water enter the cup to wet the paper towel. Each group of students was then instructed to explore the concept by choosing different materials and/or different procedures to design a new experiment. For example, one of the teams showed that air takes up space by simply blowing through a straw in a cup filled with water. They demonstrated and explained how the air formed bubbles in the water because it needed space. After the students completed their experimental designs, they carried out their investigations on the concept being studied. All investigations involved the use of science equipment. Frequently, students wanted to share their discoveries right away with their classmates. In those instances, the group stopped and observed the demonstrations of their fellow students. After students had done their explorations, they wrote about their groups' tested questions, their procedures, and their findings in their journals individually. After I looked at their journals, we continued with a whole class discussion of the concept being learned. Finally, students shared their procedures and findings with the rest of the class in a non-critical environment.

Students investigated that air has weight by blowing up balloons. Some students used different methods to prove the concept. Some used balance scales, others spring scales, empty balloons, multiple balloons, cups filled with air, etc. Another exploration involved the motion of the molecules at different temperatures. We observed different substances like soap, sugar, and many others dissolve in different temperature water. During a different lesson, we blew up a balloon by holding its neck over steam of warm water to study how molecules expand when heat is applied. Students decided to explore if anything would happen if they used ice under the balloon instead of warm water. Nothing happened at first but the students were persistent enough and after a long waiting period, their balloons did inflate slightly. That was a discovery that I did not expect and gave us a chance to discover the causes in our surrounding.

To study chemical reactions, we mixed substances like vinegar and baking soda to create a gas. We used the gas produced by the chemical reaction to blow up balloons. Students were intrigued on how it worked and some teams decided to try different proportions of the substances used while others tried using different substances to see if they got different results.

The class also made explorations with the concept of density. We studied how gases can have different weight by filling some balloons with different gases – carbon dioxide, helium, air – and observing how they floated in the air. The class also investigated the floating and sinking of different gases in the water. Floating and sinking of liquids at different temperatures in water was also studied. We experimented with balloons filled with warm and cold water. We also explored this concept with floating and sinking of solids in water. Students classified different objects of their choice before they observed if they would float or sink. Throughout the lesson, they tried different classification strategies to determine what was causing some objects to sink and others to float. They described the properties of the different objects and discussed their theories.

Instruments

Pre and Post Attitude Survey

The first data collected were the pre attitude surveys on science. Permission was granted by Heinemann Publishers (Appendix G) to use the survey in the book Nurturing Inquiry by Charles Pearce (1999). The purpose of this survey was to study the attitude of girls towards science with the use of inquiry as the method of instruction. I distributed the copies of the science attitude survey to the students and asked them to answer honestly. I read the survey aloud to the participating girls while they followed along and then defined any words they may not have understood clearly. It took twenty minutes to complete the survey as students were allowed sufficient time for reflection and answering. The same survey was used as the post attitude survey at the end of the study and the same administration procedures were followed.

The survey was examined in three categories: Affective, Perception of Inquiry Methods as Catalysts for Learning, and Perception of Science as Part of the Child's World. Student surveys were scored on a scale from 1 to 4. The scores were analyzed in alignment with observations, and interview and journal responses to describe students' attitudes with inquiry-learning.

Observations

During the study, I conducted observations of my female students' participation with inquiry learning in science. Besides qualitative observations, I also gathered data on girls' participatory behaviors. I developed an observation table based on the behaviors recorded in the female participation studies by Jovanovic & King (1998) and Dreves & Jovanovic (1998). Permission was obtained from J. Jovanovic to use the measures used in her research (Appendix F). In the Dreves & Jovanovic (1998) study, the following student activities/roles were observed: Directing, reading directions, following, manipulating, assisting, note-taking, observing, suggesting, explaining, requesting explanation of content, and requesting information. The results in that study were discussed in either passive-assisting, active-leading, or active-manipulating behavior categories (see Appendix D). For my study, I constructed a table that included these three categories with modifications (see Appendix D). Under active-leading behaviors, I included directing, suggesting, and explaining. Under active-manipulating behaviors, I included manipulating, record-keeping, and reading directions. Under passive-assisting behaviors, I included assisting, following, and observing. The table was used to record girls' participation in inquiry-based science learning. Video cameras were used to record the observations during the science lessons. I used the video tapes after each class to check the accuracy of the observations I recorded during class.

Each participant was observed and data were collected on each student's participation during each class. Participants received a tally for each participation behavior. Each tally was assigned a score of "1."The behaviors were recorded into three categories – active-leading, active-manipulating, and passive-assisting. When a behavior was initiated, students received a tally in one of the three categories.

The observation table scores were calculated and the results were aligned with results from the pre and post interview, students' journals, and my qualitative observations to describe students' participation in science. Furthermore, my observations were used in conjunction with survey responses, journal entries, and interview answers to analyze students' attitude towards science.

<u>Pre and Post Interviews</u>

I conducted individual pre interviews before the study began, right after administering the science pre attitude survey. I developed a questionnaire (Appendix C) in order to be consistent with the questions I asked all participants. The purpose of the interviews was to find out the students' attitude towards science with inquiry learning and to inquire about female students' perceptions on girls' class participation in single-gender grouping.

A comfortable and private place was provided for the interviews in a back corner of the classroom that is sectioned with bookcases. The interview questions were open ended and I asked the students to be honest in their responses. All interviews were audio tape recorded. I asked the same questions and followed the same interview procedures for the post interviews.

Interview answers were aligned with attitude surveys, journals, and observations to describe participants' perceptions on single-gender grouping and to describe my female students' participation and attitude towards science.

Journals

The journals consisted of a folder containing attached copies of science discovery logs. The science discovery log (Appendix B) was reproduced from the book Nurturing Inquiry by Charles Pearce (1999). Permission to reproduce and use the log was granted by Heinemann publishers (Appendix G). The purpose of using journals was to examine students' understanding of scientific concepts and students' attitudes towards the lessons I presented. The study was not focused on academic performance but the journal entries offered a different perspective to understand implications in the results of the other three measures. Furthermore, the journal prompted the students to rate the activities after each science class.

Participants used journals to record their science explorations and findings in writing. Students were encouraged to engage in verbal sharing of ideas in cooperative groups with inquiry learning. However, they were instructed to make journal entries individually. I collected the journals after each class. Following review of their journals, I conducted class discussions about the participants' findings. We reviewed the science concepts and compared them for consistency to the students' findings without making judgments. Students did not change or correct their original entries.

Journal entries and ratings were aligned with data from the surveys, the interviews, and participation observations to describe students' participation and attitude towards science.

Data Analysis Procedures

Pre and Post Attitude Survey

Pre and post science attitude surveys (Appendix A) were used to evaluate students' attitudes from the beginning to the end of the study. The survey was examined in three categories: Affective, Perception of Inquiry Methods as Catalysts for Learning, and Perception of Science as Part of the Child's World.

A quantitative analysis of the participants' responses from the pre and post attitude surveys was carried out. In the "Affective" category, one of the indicators was written for a strongly disagree response and three of the indicators were written for a strongly agree response. In the "Perception of Inquiry Methods as Catalysts for Learning" category, four of the indicators was written for a strongly disagree response and six of the indicators were written for a strongly agree response. In the "Perception of

Science as Part of the Child's World" category, one of the indicators was written for a strongly disagree response and five of the indicators were written for a strongly agree response.

When a student responded "strongly disagree" to a question written for a strongly disagree response, a "4" was used to score this question. When a student responded "disagree", to a question written for a strongly disagree response, a "3" was used to score this question. When a student responded "agree" to a question written for a strongly disagree response, a "2" was used to score this question. When a student responded "strongly agree" to a question written for a strongly disagree response, a "1" was used to score this question. Likewise, when a student responded "strongly agree" to a question written for a strongly agree response, a "4" was used to score this question. When a student responded "agree" to a question written for a strongly agree response, a "3" was used to score this question. When a student responded "disagree" to a question written for strongly agree response, a "2" was used to score this question. When a student responded "strongly disagree" to a question written for a strongly agree response, a "1" was used to score this question. When a student responded "no opinion," a score of "0" was assigned to the question. Only one "no" opinion response was obtained in the study. It had no value and was not included in the quantitative analysis.

The following steps were taken to analyze the surveys quantitatively: Beginning with the pre survey, I added all girls' raw scores for each question in the affective category and divided the resulting total by the number of respondents to generate a mean score for each item. Then, I added up these means scores for the questions and divided the resulting total by the number of questions in this category. The results were the overall average for the affective category. The category average score represents the students' overall attitude in the category. The category average is a number that can be evaluated within the scale of 1 to 4 used in the survey. I followed the same procedures for the other two categories. The post survey scores were averaged in the same manner as the pre survey scores.

I compared the mean score of each category in the pre survey to the corresponding category mean score in the post survey to determine if the students' attitudes had changed from the beginning to the end of the study.

For further analysis, I used the pre attitude survey scores to examine each girls' responses in each category. For each student, I added the scores for all the items they answered in the affective category. The resulting sum of each student was divided by the number of questions answered to obtain a mean score. The scores were analyzed in alignment with observations, and interview and journal responses to describe students' attitudes with inquiry-learning.

Observations

Students' participatory behaviors were recorded in three categories – passive-assisting, active-leading, and active-manipulating behaviors (Appendix D). When a behavior was initiated by a student, she received a tally in one of the categories. Each tally was assigned a score of "1." The quantity of tallies in each category was added for each participant after each lesson.

The average of each student's scores in the active-leading category was found by adding the student's daily scores in the category and dividing it by the number of days when data were collected. The results of all students were compared to each other for equality in participation. In my analysis, I also compared the results of the students in group A to the results of the students in group B. Additionally, I compared students' mean scores across categories to examine which type of behavior each student exhibited more.

Finally, I added the scores of all participants obtained during each class. I divided each of the resulting sums by the number of participants. The results represent the mean scores for each type of participation on the different days of the study. I used a comparison of mean scores across days when data was collected to study changes in participation from the beginning to the end.

The observation table findings were aligned with results from the pre and post interview, students' journals, and my qualitative observations to describe students' participation in science. My qualitative observations were used in the analysis of data from survey responses, journal entries, and interview answers to examine students' attitude towards science.

Pre and Post Interviews

Student interview questions (Appendix C) were analyzed qualitatively. Responses to question 1, 2, 3, 5, and 8 in the pre interview were compared with post interview answers for the same questions. The results were analyzed with observations, journals, and surveys to study female students' participation in inquiry learning. Answers for questions 4 and 7 were studied by comparing the pre interview answers with post interview answers. The results were analyzed with observations, journals, and surveys to describe female students' attitude toward science. Answers for questions 1 and 6 were examined by comparing the pre interview answers with post interview answers. I was looking for information on how my female students' perceived their participation and the participation of girls in general in mixed-gender and single-gender grouping. The results were used to describe female students' perception of girls' participation in single-gender grouping.

Journals

Students made entries in their journals after each class. Journals were comprised of attached science discovery log sheets (Appendix B) attached in folders. The journals were analyzed qualitatively. I read the students' entries to evaluate if they understood the subject matter. Their performance informed me whether their participation was meaningful and provided quality science experiences in the classroom. The information I extracted on girls' academic performance gave me different perspectives to understand their results in other measures. Overall academic understanding was aligned with observation, survey, and interview data to examine girls' participation and attitude towards science.

Additionally, students rated the activities for each lesson in their journal entries on a scale from 0 to 10, with 0 being terrible and 10 being great. The rating represented the students' feelings about the lesson, whether they considered it to be a good exploration for their learning. I took an average of ratings for each day when data was collected. I did this by adding all the girls' scores for each day and dividing the results by the number of participants. I aligned the results of the ratings with observation, survey, and interview data to examine girls' participation and attitude towards science.

Lastly, I found the mean score for each student's rating by adding up each student's scores for all the lessons. I divided the resulting sum by the number of lessons. I aligned these scores with observation results and survey results to describe student participation with inquiry.

Credibility and Trustworthiness

All emergent themes resulted from a triangulation across methods and sources to increase the credibility of the research. The triangulation of the data included: pre and post science attitude surveys, pre and post interviews, journals, and observations.

For reliability, interviews were audio-taped and transcribed for accuracy. Video tapes of the study were used to re-check the observation data collected during the lessons. Students completed their journal entries individually and without assistance. They did not change any answers after class discussions. During the survey administration, all items were read aloud to the students and any student questions about meaning of the items were clarified.

Conclusion

Data collected from surveys, interviews, journals, and observations were gathered, analyzed, and triangulated to examine female students' participation and attitude towards science with inquiry learning methods. Students' participation in class was observed and tallied in three categories – passive-assisting, active-leading, and active-manipulating behaviors. The tallies were recorded on an observation table and converted into scores. Pre and post attitude surveys were used to measure changes in students' attitudes towards science in three categories: Affective, perception of inquiry methods as catalysts for learning, perception of science as part of the child's world. The results of the pre and post attitude survey scores were compared using quantitative analysis. Student interview responses were used to examine data on participation and attitude towards science from the surveys, observation, and journals. Student interview results were also analyzed qualitatively in order to describe students' perceptions of girls' participation in single-gender grouping. Student journals were analyzed qualitatively to find out whether science concepts were understood by students during participation in the study. Journal data were used in conjunction with data from other instruments to describe student participation and attitudes. The research results are detailed in the next chapter.

CHAPTER FOUR: DATA ANALYSIS

Introduction

The objective of my study was to examine my female students' attitude and participation in science class with the use of inquiry learning and single-gender grouping. Eight female students participated in this action research. Data were collected during a period of four weeks.

Female students' attitudes were measured in three categories: Affective, Perception of Inquiry Methods as Catalysts for Learning, and Perception of Science as Part of the Child's World. Girls' participation in class was observed in three categories – passive-assisting, active-leading, and active-assisting behaviors. Interview questions were analyzed qualitatively in order to investigate students' attitudes and perceptions of their participation as linked to inquiry and to single-gender grouping. Student journals were analyzed qualitatively to check for participation through understanding of the content and attitudes through students' ratings of the lessons.

Inquiry and Students' Attitudes

Research Question #1: What was female students' attitude towards science during inquiry lessons?

Students' attitudes towards science were assessed using different data sources in the three following categories: Affective, Perception of Inquiry Methods as Catalysts for Learning, and Perception of Science as Part of the Child's World. In each category, pre and post attitude surveys were used to measure changes in attitude. Additionally, pre and post interview responses, journal entries and observations of girls' participation were aligned with the survey results to examine girls' attitude towards science.

Affective

The pre attitude survey administered to the eight girls in the class at the beginning of the research period showed a positive affective attitude towards science. Mean scores were evaluated in the 1 to 4 scale used in the survey. A score of 4 represents a strong positive attitude while a score of 1 represents a negative attitude. Table 1 presents the mean scores from the pre attitude survey in the affective category.

Table 1: Pre Attitude Survey Class Mean for Affective Category

Survey Item	Pre Attitude Mean
1: Learning is boring.	2.88
7: Discovering answers to my own questions is interesting.	3.50
10: I like to discuss what I have discovered.	3.38
11: Learning is finding out about things that interest me.	3.38
Category average	3.28

As shown in table 1, participants' scores were higher at above 3.0 (in the scale of 1 through four) in the three items that implied a liking for science when discovering things of their interest. Item 1 scored lower (below 3.0) than other items in this category. This score does not show agreement that science was boring to the students with the traditional teaching methods they had been exposed to up to that point but it was lower than I expected.

At the end of the research period, I administered the same attitude survey as the post attitude survey to evaluate changes in students' affective attitude in science. Table 2 shows the results of the pre and post attitude survey. I added an additional column to show the change in attitude in the affective category.

Table 2 Pre and Post Attitude Survey Class Mean for Affective Category

Item Number	Pre Attitude	Post Attitude	Change in Attitude
1	2.88	3.88	1.00
7	3.50	3.63	0.13
10	3.38	3.63	0.25
11	3.38	3.50	0.12
		Category change	0.38

In the post attitude survey, students' responses for item 1 showed a change greater than 0.5, the largest change in this category. This demonstrates that participants perceived science to be less boring after having experiences with inquiry learning. Changes in the other three items were less that 0.5 but higher than 0, thus showing a positive change in attitude towards science.

As I described in detail in the next section of this chapter, overall, students became more active participants by the end of the study. The feeling of being a more active part of the group may have contributed to the positive change in attitude.

For further analysis, I used the pre attitude survey scores in this category to examine each student's responses in light of their pre interview responses. Table 3 lists the mean score for each student in the pre attitude survey. In the pre attitude survey, one out the eight participants showed agreement below 3.0 (in the scale of 1 through 4, where is the represents the most positive attitude). The other seven participants showed agreement above 3.0.

Table 3: Pre Attitude Survey Mean of Student Responses for Affective Category

Student	Mean Scores for Student Responses
Ann	3.75
Jennifer	3.50
Leah	3.25
Mary	3.25
Pam	2.50
Rebecca	3.25
Sarah	3.50
Tara	3.25

I conducted pre interviews prior to the beginning of the study. In the affective category, students were asked if they liked doing science work and experiments from the textbooks, or doing inquiry experiments better. They were also asked if they liked to discuss what they had learned with the members of their group.

During the pre interview, five out of eight students showed preference of inquiry experiments over work and experiments from the science textbook while the other three participants preferred the textbook. Pam had the lowest mean score in the affective category in the pre attitude survey. However, during the pre interview, she said she liked inquiry experiments more than work from the textbooks "[because] it is fun." Ann, Rebecca, and Jennifer showed a stronger liking for inquiry science in the pre attitude survey. However, during the pre interview, they stated that they preferred to do the experiments in the textbooks instead of inquiry. Rebecca explained that she preferred the textbook because it "tells directly what to do and stuff." In other words, she may not have been comfortable at this point with having to design new experiments and make the effort to think of ways to explore and interpret the concepts, as it is required during inquiry learning. All participants responded that they like to discuss what they have learned with members of their group. Rebecca, however, added that she likes to discuss the results only when she doesn't understand. When she understands the results, she does not "feel like [discussing the results]."

Table 4 lists the mean score for each student in the pre and post attitude surveys. I added a column to list the change in attitude for each student.

Table 4: Pre and Post Attitude Survey Mean of Student Responses for Affective Category

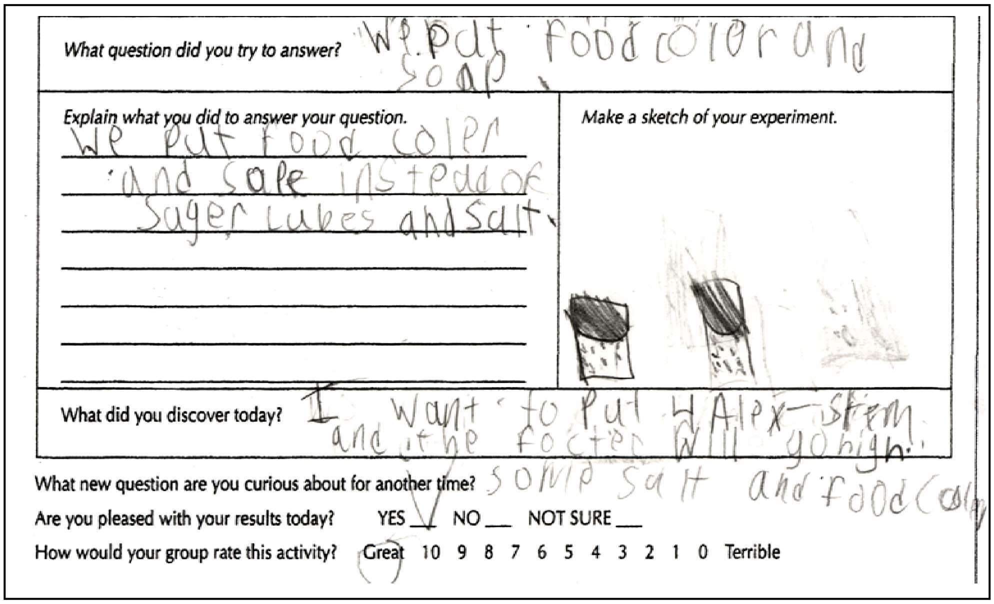
Student	Pre Attitude Responses	Post Attitude Responses	Change in Student Responses
Ann	3.75	3.50	-0.25
Jennifer	3.50	3.25	-0.25
Leah	3.25	3.25	0.00
Mary	3.25	4.00	0.75
Pam	2.50	4.00	1.50
Rebecca	3.25	4.00	0.75
Sarah	3.50	3.50	0.00
Tara	3.25	3.75	0.50

In the post attitude survey, all students showed a positive attitude towards science in the affective category. Four of the eight participants showed a more positive attitude by an increase in score of 0.5 or above. Two students did not show any change, two students showed a small negative change of -0.25. Pam showed the biggest change in attitude with the highest possible score for all items on post attitude survey, yielding a mean of 4.0 for the category.

I conducted post interviews at the end of the study. Just as in the pre interviews, students were asked if they liked doing science work and experiments from the textbooks, or doing inquiry experiments better. They were also asked if they liked to discuss what they had learned with the members of their group.

During the post interview, all participants said they liked to discuss what they had learned with members of their group. Six out of the eight participants said they preferred doing inquiry experiments over doing science work and experiments with the textbooks during the post interviews. Ann, Jennifer, and Rebecca, who expressed preference for textbooks before the study, said they preferred inquiry learning at the end of the study. Rebecca's change of attitude of 0.75 shown between the surveys was consistent with her post interview response, saying that she liked it "because it's really fun." Ann and Jennifer showed a negative change of 0.25 in attitude between the surveys, which was inconsistent with the positive change between their pre and post interview responses. However, their attitude scores still show a strong positive attitude towards inquiry at 3.50 and 3.25 on the 1 to 4 scale.

Sarah and Leah did not show a change in attitude towards inquiry between the surveys. Nevertheless, their interview responses indicated that they preferred working with textbooks over inquiry. Sarah stated that she preferred the textbooks "because they have already done the experiments so instead of doing them you can just read it." I believe that Sarah did not enjoy the inquiry experiments as much during the study because her group participation was mostly passive. As I will discuss in a later section of this chapter, Sarah's participation was limited partly because of the strong control that two of her group members took as leaders. Sarah did not seem content with the arrangement. Leah may not have enjoyed working with inquiry experiments because, although she was an active participant as I will detail in a later section of this chapter, she did not comprehend well the science concepts being learned. In working with Leah, I have learned that she becomes uncomfortable when she has difficulty understanding an assignment. Figure 1 shows an entry from her journal.



What question did you try to answer? We put food color and soap.

Explain what you did to answer your question. We put food coler and sope instead of sager cubes and salt.

Make a sketch of your experiment.

What did you discover today? I want to put 4 Alex-stem and it he focter will go high.

What new question are you curious about for another time? some salt and food color

Are you pleased with your results today? YES ✓ NO ___ NOT SURE ___

How would your group rate this activity? Great 10 9 8 7 6 5 4 3 2 1 0 Terrible

Figure 1: Journal Entry by Leah

In this experiment, Leah's group was trying to explore and compare how substances dissolve in cold and hot water. Her understanding was limited to knowing that different substances were being placed in water. However, Leah did not understand what the group was trying to investigate. During my observations, Leah demonstrated active participation behavior but she seemed interested in just playing with the science materials and equipment instead focusing on discovery attempts. In the post interview, she did share that she likes discussing what she has learned with members of her group "because [they] have a great time" but she does not like to focus on the academics.

At the end of each class, students were asked to rate the inquiry activity on a scale from 0 to 10, 0 being terrible and 10 being great. For each student, I added the ratings for all the classes and divided the calculated sum by the number of classes. This resulted in the mean rating for each student throughout the study. Figure 2 illustrates the results.

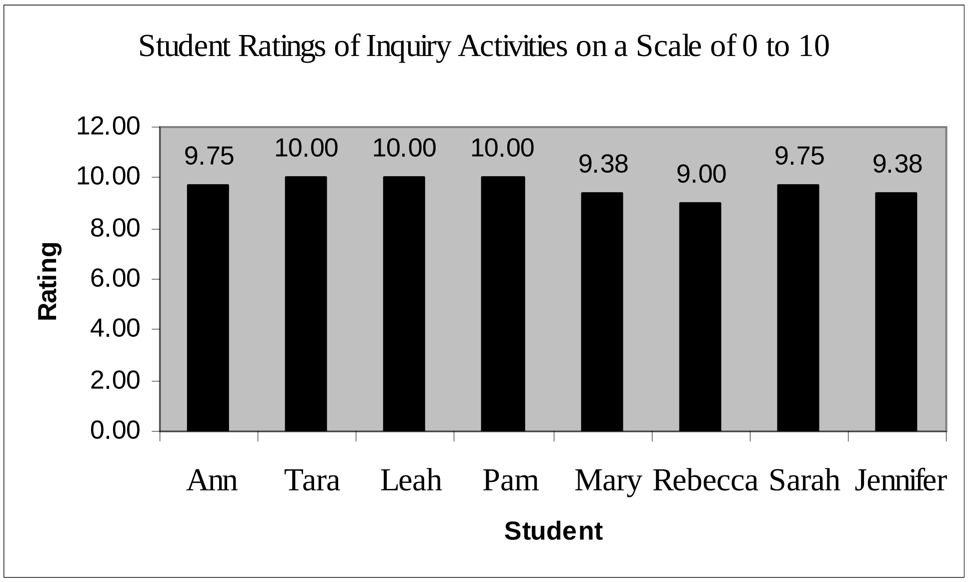


Figure 2: Individual Student Ratings of Inquiry Activities

As show in figure 2, all students rated the inquiry lessons in the study favorably with a mean of 9.0 or above. The results for these ratings are consistent with the positive change in attitude towards science manifested in comparing the pre and post survey responses. In my observations, I noticed frequent expression of excitement when discoveries were made by the students in class. I often had to ask all the students to stop what they were doing to listen to their classmates who had findings that they wanted to share.

A positive attitude towards science using inquiry methods was shown by the results of the three measures used to analyze this attitudinal category of the study. The attitude surveys showed an overall score increase of 0.38 on a 1 to 4 scale. In the post interview, six out of eight students said that they preferred inquiry learning methods over studying science with traditional methods in the post interview. Students rated the inquiry activities in the study highly at 9.0 or above in a 0 to 10 scale with 10 being great and 0 being terrible. Overall, students' attitudes towards science in the affective category were more positive at the end of the study.

<u>Perception of Inquiry Methods as Catalysts for Learning</u>

The pre attitude survey administered to the eight girls in the class at the beginning of the research period showed that students, who had been taught with traditional methods, perceived inquiry methods as valuable for learning. Table 5 represents the mean scores from the pre attitude survey in the category of perception of inquiry methods as catalysts for learning.

Table 5: Pre Attitude Survey Results for Perception of Inquiry Methods as Catalysts for Learning Category

Survey Item	Pre Attitude Mean
2: I learn best by reading chapters and answering questions	1.63
3: As I learn, it is important to think about my thinking	3.50
4: I learn more if I have a choice about what I will be learning	2.86
5: When I talk things over with my partner I understand more about what I am learning	3.50
6: I learn more when I work in a group and share ideas	3.63
8: The best way to measure learning is for my teacher to give tests	1.88
9: My teacher can measure my learning by reading my journal	3.00
16: Science textbooks are the best to read to learn about science	1.75
18: I can learn more by reading than by doing	2.00
19: Facts I discover are more memorable than facts someone tells me	3.75
Category average	2.75

As shown in table 5, four items scored low at 2.0 or below (in the scale of 1 through 4, where is the represents the most positive attitude) while five items scored 3.0 or above. Participants' scores showed low agreement (2.0 or below) with items 2, 16, and 18. This implies that students perceived books as better tools for learning than hands on activities. A low score (below 2.0) for item 8 demonstrated that participants agreed that tests are the best way to measure learning. Higher participant agreement was shown with various items which implied that communication with group members is helpful for learning.

At the end of the research period, I administered the same attitude survey as the post attitude survey to evaluate changes in students' perceptions of inquiry as a catalyst for science learning. Table 6 shows the results of the pre and post attitude survey. I added an additional column to show the change in this attitudinal category.

Table 6: Pre and Post Attitude Survey Results for Perception of Inquiry Methods as Catalysts for Learning Category

Survey Item Number	Pre Attitude Mean	Post Attitude Mean	Difference
2	1.63	2.25	0.62
3	3.50	3.50	0.00
4	2.86	3.75	0.89
5	3.50	3.75	0.25
6	3.63	4.00	0.37
8	1.88	2.75	0.87
9	3.00	3.13	0.13
16	1.75	2.13	0.38
18	2.00	3.13	1.13
19	3.75	3.63	-0.12
		Category change	0.45

As shown in table 6, three items had changes higher than 0.5 while 7 items had changes lower than 0.5. After participation in inquiry learning, students' responses show a change in agreement with those items that implied that science books are better tools for learning than hands on activities. A change in responses for item 8 indicates that students did not agree that tests are the best form of assessment

For further analysis, I used the pre attitude survey scores in this category to examine each student's responses in light of their pre interview responses. For each student, I added the scores for all the items answered in this category. To obtain a mean score, the sum was divided by the number of questions answered. Table 7 lists the mean score for each student in the pre attitude survey.

Table 7: Pre Attitude Survey Mean of Student Responses for Perception of Inquiry Methods as Catalysts for Learning Category

Student	Mean Scores for Student Responses
Ann	2.80
Jennifer	2.70
Leah	2.80
Mary	2.70
Pam	2.50
Rebecca	3.10
Sarah	2.60
Tara	2.50

In the pre attitude survey, seven out of the eight participants showed agreement below 3.0 (in the scale of 1 through 4, where 4 represented the most positive attitude). Only one participant showed agreement above 3.0.

I conducted pre interviews prior to the beginning of the study. In relation to this survey category, students were asked if working in a group and sharing ideas helped them learn more. They were also asked if talking things over with other students in their group helped them better understand what they learned. I chose these questions for this category because communication among group members was imperative during the study in order for them to understand the concepts and be able to plan and carry out inquiry investigations. This data were also related to my interest in their group participation.

During the pre interview, all eight students agreed that they understand better what they learn when they talk things over with other students in their group. Seven out of the eight participants agreed that they learn more when they work in a group and share ideas. Rebecca did not agree because she "usually like[s] to do that alone." As mentioned in the interview discussion for affective attitude, Rebecca also mentioned that she likes to discuss the results only when she doesn't understand but she doesn't mind doing it when she understands.

Table 8 lists the mean score for each student in the pre and post attitude surveys. I added a column to list the change in attitude for each student.

Table 8: Pre and Post Attitude Survey Mean of Student Responses for Perception of Inquiry Methods as Catalysts for Learning Category

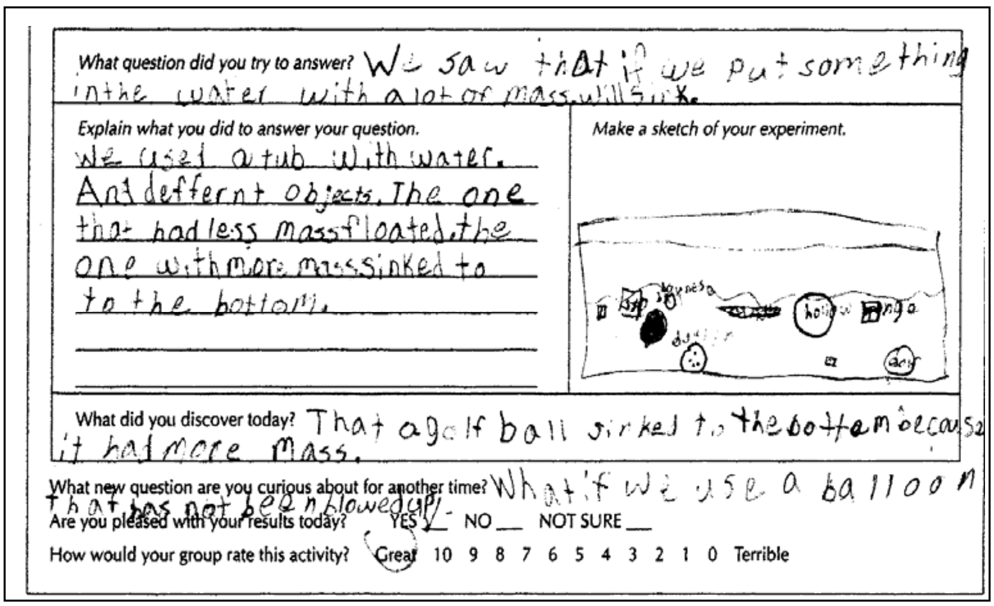
Student	Pre Attitude Responses	Post Attitude Responses	Change in Student Responses
Ann	2.80	3.50	0.70
Jennifer	2.70	3.30	0.60
Leah	2.80	3.20	0.40
Mary	2.70	2.90	0.20
Pam	2.50	2.90	0.40
Rebecca	3.10	3.30	0.20
Sarah	2.60	3.20	0.60
Tara	2.50	3.30	0.80

In the post attitude survey, all participants showed a more positive attitude towards science in this category than they did in the pre attitude survey. Six of the eight participants gave scores higher than 3.0 in the scale of 1 to 4. Both the other participants showed mean scores of 2.9. All students showed a positive change in attitude towards science in this category. Four of the eight participants showed an increase in score of 0.5 or above and four showed an increase less than 0.5. Tara, who was tied with Pam for the lowest pre attitude survey scores in this category, showed the biggest change in the post attitude survey. Her score went up by 0.8.

I conducted post interviews at the end of the study. Just as in the pre interviews, students were asked if working in a group and sharing ideas helped them learn more. They were also asked if talking things over with other students in their group helped them better understand what they learned.

During the post interview, all participants said they learn more when they work in a group and share ideas. Seven out of the eight participants said they understand better what they learn when they talk things over with other students in their group, while one participant said she did not know. Rebecca, who did not agree with this in the pre interview, changed her perception and in the post interview said it was “because if [she doesn’t] understand something, [she] can just ask [members of her group].” To this question, Leah responded “I don’t know.” As previously noted in the discussion for the affective category results, Leah did not understand well the science concepts being learned. She likes discussing what she has learned with members of her group “because [they] have a great time” but she does not like to focus on the academics.

I made a thorough review of the participants' journals. It was evident that all participants, with the exception of Leah, had an understanding of the concepts being explored in science. Children were exposed to moderate to challenging concepts during this study and their performance was appropriate for second grade level. This is consistent with the increase of scores between the pre and post attitude surveys in this category. The participants may have attributed their good academic performance during the study to the inquiry methods being used. The journal entry in figure 3 is a typical representation of participants' work during the study.



What question did you try to answer? We saw that if we put something in the water with a lot of mass will sink.

Explain what you did to answer your question. We used a tub with water. And defferent objects. The one that had less mass floated, the one with more mass sinked to to the bottom.

Make a sketch of your experiment.

What did you discover today? That a golf ball sinked to the bottem because it had more mass.

What new question are you curious about for another time? What if we use a balloon that has not been blowed up.

Are you pleased with your results today? YES ✓ NO ___ NOT SURE ___

How would your group rate this activity? Great 10 9 8 7 6 5 4 3 2 1 0 Terrible

Figure 3: Student journal entry 1

The results of the ratings in the students' journals are consistent with the positive change in attitude found in the Perception of Inquiry Methods as Catalysts for Learning category. In the students' journal entries, all students rated the inquiry lessons in the study favorably with a mean of 9.0 or above, where 10 stands for "great" and 0 stands for “terrible.” This means that students found the inquiry-based lessons to be valuable to their learning.

A more positive attitude towards science using inquiry methods was shown by the results of the measures used to analyze this attitudinal category of the study. The attitude surveys showed an overall score increase of 0.45 on a 1 to 4 scale. The pre-interview scores for this category were lower than the pre-interview scores for the other two categories. I think this could have been the result of girls’ exposure to traditional teaching methods and unfamiliarity with inquiry at the beginning of the study. After becoming familiar with the benefits of inquiry, their attitude changed. In the post interview, all eight participants said that they learned more by working in a group and sharing their ideas in inquiry lessons. Seven out of eight students said that they understood better what they learned when they talked things over with other students in their group during inquiry lessons. Overall, students’ attitudes towards science in this category were more positive at the end of the study.

Perception of Science as Part of the Child’s World.

The pre attitude survey administered to the eight girls in the class at the beginning of the research period showed that children perceived science favorably as part of their world. Table 9 presents the mean scores from the pre attitude survey in the category of perception of science as part of the child’s world. As shown in table 9, two items scored lower than 3.0 and four items scored 3.0 and above (in the scale of 1 through 4, where is the represents the most positive attitude). Participants’ scores were lower at 2.75 on item 13 (I am a scientist) and item 20 (Reading, math, and social studies are all parts of science). Overall, students showed awareness of the role of science in their world but they were less likely to see themselves as scientists.

Table 9: Pre Attitude Survey Results for Perception of Science as Part of the Child's World Category

Survey Item	Pre Attitude Mean
12: Learning about science is only important for kids who want to become scientists	3.00
13: I am a scientist	2.75
14: I enjoy reading picture books	3.88
15: A scientist asks questions	3.25
17: Scientists should answer old questions before asking new ones	3.00
20: Reading, math, and social studies are all parts of science	2.75
Category average	3.10

At the end of the research period, I administered the same attitude survey as the post attitude survey to evaluate changes in students' perceptions of science as part of their world. Table 10 shows the results of the pre and post attitude survey. I added an additional column to show the change in this attitudinal category.

Table 10: Pre and Post Attitude Survey Results for Perception of Science as Part of the Child's World Category

Survey Item Number	Pre Attitude Mean	Post Attitude Mean	Difference
12	3.00	3.75	0.75
13	2.75	3.63	0.88
14	3.88	3.38	-0.50
15	3.25	3.75	0.50
17	3.00	3.75	0.75
20	2.75	3.13	0.38
		Category change	0.46

As shown in table 10, all items but one in this category had changes of 0.5 or above. After participation in inquiry learning, the change in item 12 reflected that students have stronger agreement that science is important to them. The change in item 13 suggests that students view themselves as scientists more than they did before the study. A change in item 17 reflects their learning of scientific practices during inquiry lessons. During the study, students worked on investigating scientific questions and formulating new questions.

For further analysis, I used the pre attitude survey scores in this category to examine each student's responses in light of their pre interview responses. For each student, I added the scores for all the items answered in this category. To obtain a mean score, the sum was divided by the number of questions answered. Table 11 lists the mean score for each student in the pre attitude survey.

Table 11: Pre Attitude Survey Mean of Student Responses for Perception of Science as Part of the Child's World Category

Student	Mean Scores for Student Responses
Ann	3.00
Jennifer	3.33
Leah	3.50
Mary	3.50
Pam	2.17
Rebecca	3.00
Sarah	3.67
Tara	2.67

In the pre attitude survey, two out the eight participants showed agreement below 3.0 (in the scale of 1 through 4, where is the represents the most positive attitude). The other six participants showed agreement at or above 3.0. Pam's mean score was the lowest of all participants.

Table 12 lists the mean score for each student in the pre and post attitude surveys. I added a column to list the change in attitude for each student.

Table 12: Pre and Post Attitude Survey Mean of Student Responses for Perception of Science as Part of the Child's World Category

Student	Pre Attitude Responses	Post Attitude Responses	Change in Student Responses
Ann	3.00	3.67	0.67
Jennifer	3.33	3.83	0.50
Leah	3.50	3.50	0.00
Mary	3.50	3.33	-0.17
Pam	2.17	4.00	1.83
Rebecca	3.00	3.00	0.00
Sarah	3.67	3.83	0.16
Tara	2.67	3.33	0.66

In the post attitude survey, five out of the eight participants showed a more positive attitude towards science in this category than they did in the pre attitude survey. Two of the eight participants showed no change. One participant had a negative change of -0.17. At the end of the study, 5 participants showed mean scores of 3.5 or above in the 1 to 4 scale. The other 3 students showed scores higher than 3.0 but less than 3.5. Pam, who had the lowest pre attitude survey scores in this category, showed the biggest change in the post attitude survey. Her score went up by 1.83.

All girls showed a positive attitude towards science in this category. The overall category change in score in the scale of 1 to 4 was 0.46, the biggest change among the three categories in the surveys.

In summary, girls' attitudes towards science became more positive as a result of their experiences with inquiry learning. There was a change between the mean scores for the pre and the post attitude surveys of 0.43 in the 1 to 4 scale. This may be partly related to the observations, which showed increased active participation within groups. In the post interview, six out of eight students said that they preferred inquiry learning methods over studying science with traditional methods in the post interview. All eight participants said that they learned more by working in a group and sharing their ideas in inquiry lessons. Seven out of eight students said that they understood better what they learned when they talked things over with other students in their group during inquiry lessons. Students rated the inquiry activities in the study highly at 9.0 or above in a 0 to 10 scale with 10 being great and 0 being terrible. Seven out of eight students demonstrated effective active engagement in learning through their journal entries. Female students' confidence in their academic performance may have translated in a more positive attitude towards science.

Inquiry and Student Participation

Research Question #2: How did female students participate in science class during inquiry lessons?

I examined student participation in inquiry learning classes by triangulating data from my observations, girls' interview responses, journal entries and ratings, and attitude survey responses. First, I described the interview results to inform the reader of students' perspectives of their participation. I then described the participation using the data from my observations in three categories – passive-assisting, active-leading, and active-manipulating behaviors. To analyze the types of behaviors from my observations, I compared the participants' scores in each category. I looked for patterns to find similarities and differences in participation between students. Finally, I made a comparison across categories. During all the data discussions, I included relevant relationships with data from interview responses, journal entries and ratings, and attitude responses.

The eight participants were divided into two groups of four students, groups A and B. Each group had two high achievers (grades A in report card), one student confident at grade level (grades B in report card), and one student struggling at grade level (grades C and D in report card). During my observations, I found that the group dynamics were different in group A than in group B. Therefore, in the discussion, I analyzed the data for the students in relation to their respective group.

I conducted interviews at the beginning and at the end of the study. Three relevant questions to participation were asked during the pre and post interviews. One prompted the students to describe how much they participated in their group as compared to other students. A second question inquired whether everyone in the group participated. The third question asked whether students participated more with inquiry learning or with classes that included work and experiments from the textbooks.

In the pre interview, six out of the eight participants believed that they participated the same as others in their group. Tara and Sarah believed that they participated more than other students in their group. All eight students replied that everyone in their group participated. Five out of the eight participants responded that they participated more during inquiry-based learning than with textbook-based science classes.

In the post interview, seven out of the eight participants, replied that they participated the same as other students in the class. Tara and Sarah no longer thought that they participated more. I believe that the experience of the pre interview and the study allowed them to think about their group participation differently. As will be discussed in the next section of this chapter, Tara's participation scores were neither the highest nor lowest of the girls' scores. Sarah's participation was more passive than that of the other participants. Jennifer claimed that she participated more than others.

During the interviews, six out of the eight participants said that everyone in their group participated. Jennifer did not agree and Mary, who had the second lowest participation score in this category, said she did not know. I believe that Mary said she did not know because she may not have wanted me to think that some students were participating less than others.

Six out of the eight participants said they participated more with inquiry learning than with textbook based classes. Sarah and Leah's responses did not change from the pre interview. Leah replied that she participated more using the textbooks "because it helps you more." Sarah stated that she participated more using textbooks "because [she] know[s] how to read good." As discussed in a previous section of this chapter, Leah had difficulty following the concepts being learned with inquiry learning methods. She enjoyed the interaction but was not able to extract understanding from it. Her answer to this question in the post interview may be related to her need for structured direction. Sarah had the lowest score in the active-leading category and the highest score in the passive-assisting category as will be discussed in the following sections. Sarah appeared timid by nature so her preference for textbooks to learn science might be cause by her shyness in interacting with members of her group. During the pre interview, Tara said that she participated more when using the book for science learning than with inquiry learning. However, in the post interview, she said she participated more with inquiry learning "because it's fun."

Active-Leading Participatory Behavior

Active leading behaviors included directing, suggesting, and explaining. A student earned a score of 1 with a tally mark upon initiating a behavior. Table 13 shows the mean scores for student participation in science class.

Table 13: Student Mean Scores for Active-Leading Participation

Group	Student	Active-Leading
A	Ann	3.50
A	Tara	3.50
A	Leah	4.63
A	Pam	4.63
B	Mary	2.50
B	Rebecca	3.25
B	Sarah	2.25
B	Jennifer	4.00
	Average:	3.53

As demonstrated in table 13, the scores for group A show that all students obtained a mean of 3.5 or more leading participation. Leah and Pam show a higher tendency to take leading roles than Ann and Tara. In my observations, I noticed that the cooperation among the members of this group seemed somewhat uniform. In group B, the situation was very different. Mary and Sarah took on leading behaviors very seldom while Rebecca and Jennifer competed to lead, with Jennifer usually winning. The scores for group B in the table above support this observation. Three of the four students in group B obtained a mean score of less than 3.5 (the lowest obtained by any student in group A) for leading behaviors, while only Jennifer obtained a mean of more than 3.5 for leading actions. Sarah and Mary had the two lowest scores for active-leading participation.

In the post interview, Jennifer said that she participated “maybe a little bit more” than others in her group. When asked if everyone in her group participated, Jennifer said “no, no one really participates because [Rebecca] kind of bosses us around a bit” and she continued describing how Rebecca commanded each of the team members what to do. Jennifer was unaware that she was exhibiting more of a leading role than Rebecca but she did recognize that she participated more than others. Sarah said that she participated more in class when textbooks were used than during inquiry learning. This is reflected in her low score in this category.

In my observations, I found that girls in group A had a more cooperative participation with active-leading behaviors than the girls in group B. In group B, two girls exhibited less active-leading behaviors and the other two took on more leading roles. Figure 4 compares the mean participation scores for group A to the mean participation scores for group B on each day of the experiment. As shown on figure 4, on five out of eight days, group A exhibited more leading behaviors than group B. This may be attributed to the cooperative ambiance in group A, while group B had a more competitive environment.

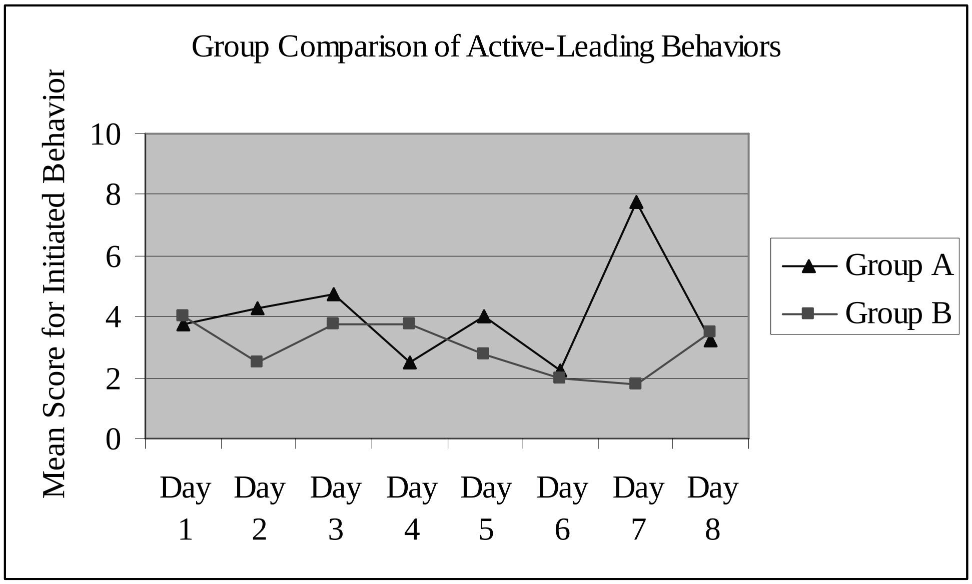


Figure 4: Group Comparison of Active-Leading Behaviors

Inquiry learning allowed girls to actively participate in leading tasks. Overall, every girl had the opportunity to exhibit active-leading behaviors with inquiry learning. The highest individual mean score obtained by any participant in this category was 4.63 and the lowest was 2.25. The average for the mean scores was 3.53. Only three of the eight participants had scores above the average. This showed that few participants in each group had more tendency to lead than others.

Active-Manipulating Participatory Behavior

Active-Manipulating behaviors included manipulating equipment, record keeping, and reading directions. A student earned a score of 1 with a tally mark upon beginning a behavior with self-initiative. Table 14 shows the mean scores for student participation in science class. I added a column with the active-leading mean scores to the right for reference. I referred to them during the discussion.

Table 14: Student Mean Scores for Active-Manipulating Participation

Group	Student	Active-Manipulating	Active-Leading
A	Ann	3.00	3.50
A	Tara	2.25	3.50
A	Leah	3.00	4.63
A	Pam	2.38	4.63
B	Mary	2.25	2.50
B	Rebecca	2.00	3.25
B	Sarah	2.25	2.25
B	Jennifer	2.00	4.00
	Average:	2.39	3.53

As demonstrated in table 14, the scores for group A show that all students obtained a mean of 2.5 or above for active-manipulating participation. Ann was one of the students who exhibited less leading behaviors in this group but she participated more actively in this category. Tara, the timid member of group A, was the other student in this group with the lower score for active-leading. She had the lowest score for the active-manipulating category as well.

While lowest score obtained by any student in group A was 2.25, it was also the highest score obtained by any student in group B. Group B exhibited a lower overall mean score for participation than group A in this category as well. Here is one example from my observations that may help explain these results. In one instance, Sarah tried to grab an instrument to help out during a group investigation. Rebecca, who was said to “boss” others around, held on to the instrument and would not let Sarah take it because she didn’t think it was the appropriate time to use it. Sarah, who is rather timid, tried to object by telling her that she “would tell Ms. Estrada,“ but she was not strong enough to convince Rebecca to let her have the instrument. Sarah eventually gave up and took the role of the observer. Events like these discouraged participation for the less assertive group members in group B.

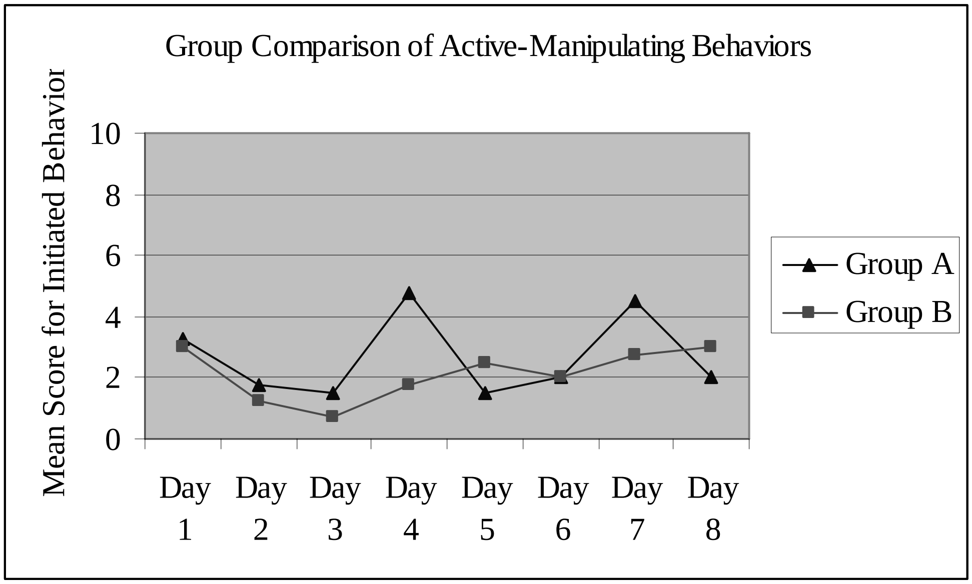


Figure 5: Group Comparison of Active-Manipulating Behaviors

In my observations, I found that group A took turns reading directions and handled the equipment more freely, resulting in a higher number of initiated behaviors in this category. In group B, there was more waiting around for leading group members to give directions of what to do. However, the planning and following orders resulted in scores that are very similar for all members of the group in this category. Two of the team members had mean scores of 2.00 and the other two had mean scores of 2.25. That’s a gap of only 0.25 between the lowest and highest score. Team A had a larger gap

(0.75) between the lowest (2.25) and highest (3.00) mean score for the members of the team.

Mary and Sarah, the students with the lower scores for active-leading behaviors in team B, obtained the higher scores for active-manipulating behaviors in their team. Likewise, Rebecca and Jennifer, the two “leaders” of team B, obtained lower scores for active-manipulating.

Figure 5 compares the mean participation scores for group A to the mean participation scores for group B on each day of the experiment in this category.

As shown on figure 5, on five out of eight days, group A exhibited more active-manipulating behaviors than group B. This may be attributed to the free environment in group A. Group B had a more structured environment created by the more leading group members.

Inquiry learning allowed girls to actively participate in active-manipulating tasks. Overall, every girl had the opportunity to exhibit active-manipulating behaviors with inquiry learning. The highest individual mean score obtained by any participant in this category was 3.0 and the lowest was 2.0. The average for the mean scores was 2.39. Only two of the eight participants had scores above the average. This represents the fact that each group had participants with more tendency to engage in active-manipulating behaviors than others. Six of the eight participants had mean scores between 2.0 and the average. The small gap between those numbers (0.39) shows a similarity in the participation of most students in the active-manipulating category.

Passive-Assisting Participatory Behavior

Passive-Assisting behaviors included assisting others, following others' instructions, and observing. A student earned a score of 1 with a tally mark upon initiating a behavior. In instances where a student manipulated the equipment with the sole purpose of assisting another group member, who had initiated manipulation with the purpose of investigating something, the student got a tally mark in this category, not in the active-manipulating category. An example is someone who steps in to hold a funnel in place for someone who had taken an initiative and was in the middle of trying out an idea. Table 15 shows the mean scores for student participation in science class. I added two columns to the right with the mean scores for the active-leading and the active-manipulating categories for reference, as I will refer to them during the discussion.

Table 15: Student Mean Scores for Passive-Assisting Participation

Group	Student	Passive-Assisting	Active-Leading	Active-Manipulating
A	Ann	1.13	3.50	3.00
A	Tara	1.75	3.50	2.25
A	Leah	1.00	4.63	3.00
A	Pam	0.75	4.63	2.38
B	Mary	2.25	2.50	2.25
B	Rebecca	1.75	3.25	2.00
B	Sarah	3.00	2.25	2.25
B	Jennifer	1.25	4.00	2.00
	Average:	1.61	3.53	2.39

As shown in table 15, for each student, the mean score in the passive-assisting category is lower than both in the active-leading and in the active-manipulating categories. This means that students' participation was more active than passive during inquiry learning. Sarah is one exception. She scored higher in the passive-assisting category than in both other categories. As mentioned in the previous section, Sarah is a timid member in group B, where two strong leading group members controlled the team. Mary scored the same in the passive-assisting category as in the active manipulating category. She was the other non-leading member of group B. Rebecca and Jennifer's strong leading personalities had an effect in the dynamics of group B. I believe that Mary and Sarah's participation scores might have been different if that hadn't been the case.

Overall, group B showed higher mean scores than group A in this category. Sarah and Mary had the highest scores because they spent a lot of time observing, following directions, and assisting the leading group members. Figure 6 shows a group comparison of passive-assisting behaviors.

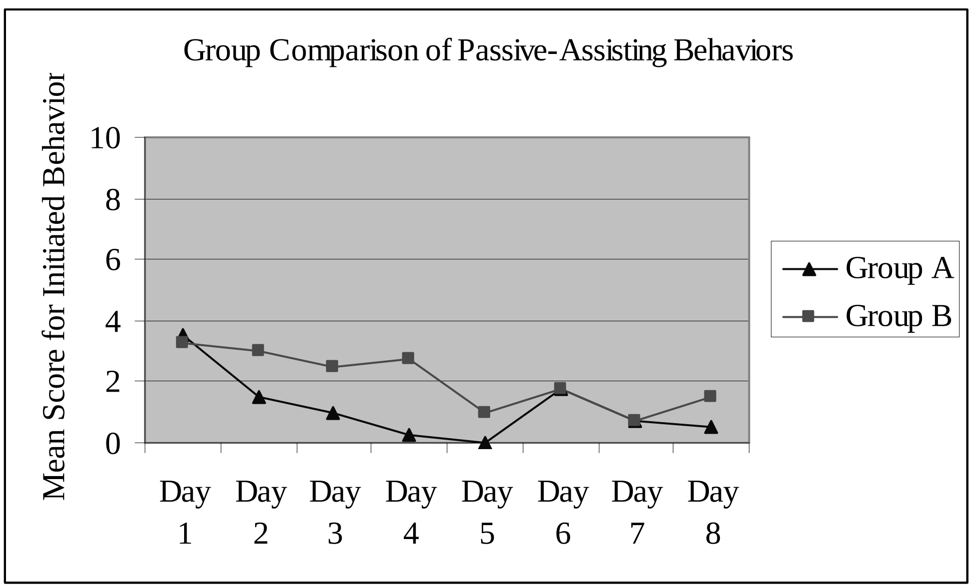


Figure 6: Group Comparison of Passive-Assisting Behaviors

As shown in figure 6, on six out of the eight days of data collection, group B exhibited more passive-assisting behaviors than group A. The members of group B were more likely to observe and assist.

The lowest score in this category was 0.75 and the highest was 3.00. The average for the mean scores in this category was 1.61. Four out of the eight participants scored above the average. Overall, students engaged less in passive-assisting behaviors than in active-leading and active-manipulating behaviors. This means that inquiry methods encourage students to be active learners.

<u>Comparison of Participatory Behaviors</u>

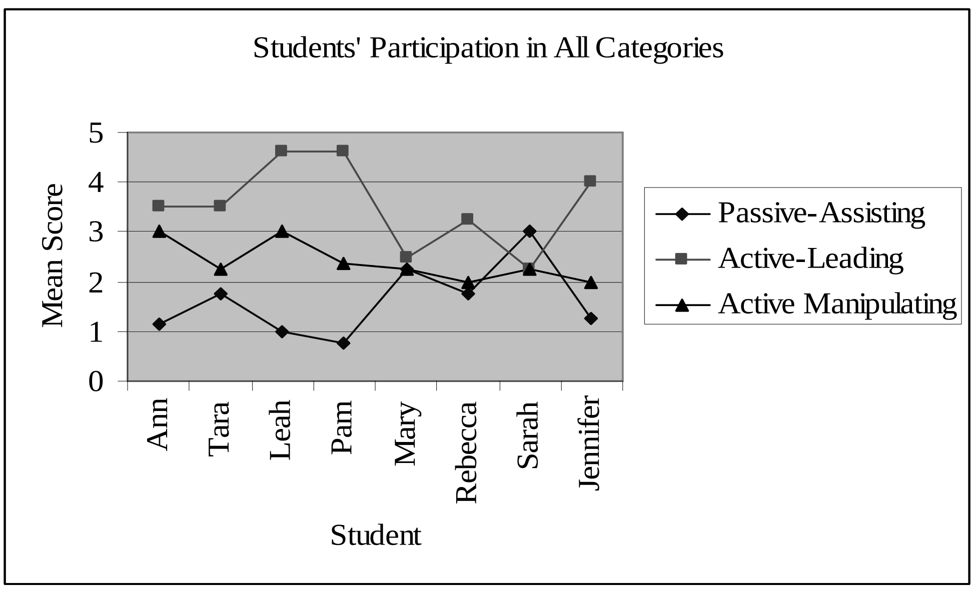


Figure 7: Students' Participation in All Categories

The students with the lowest mean scores for the active-leading category in both groups A and B, have the highest mean scores in the passive-assisting category.

Similarly, the students with the highest mean scores in the active leading category had the lowest scores in the passive-assistive categories. These results show that some students were more likely to lead and other students were more likely to follow. Figure 7 shows a comparison of students' participation in all 3 categories.

As shown in figure 7, most students exhibited more active-leading participatory behaviors than passive-assisting or active-manipulating participatory behaviors. Most students exhibited more active-manipulating participatory behaviors than passive-assisting participatory behaviors. These results show that using inquiry methods in science classrooms allows students opportunities to participate actively in their learning.

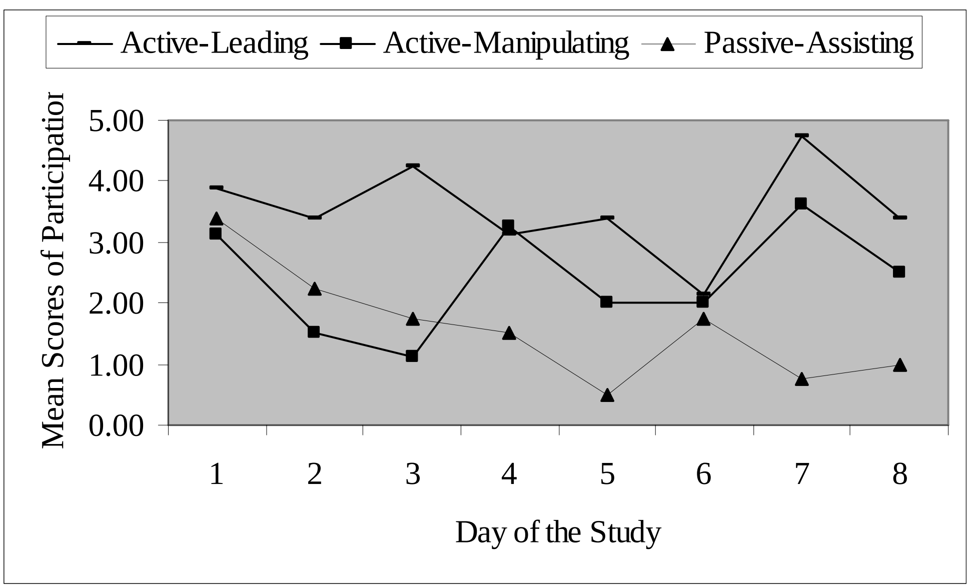


Figure 8: Comparison of Participation across Categories

For each category, I added the scores of all participants obtained during each class. I divided each of the resulting sums by the number of participants. The results represent the mean scores for each type of participation on the different days of the study. I compared the results across days and categories in the figure 8.

As shown in figure 8, overall student participation in the active-leading category was rather steady throughout the study. Overall student participation in the active-manipulating category increased as the days of the study progressed. Passive-assisting behaviors decreased as the days of the study progressed. This showed that students were active participants during inquiry learning experiences.

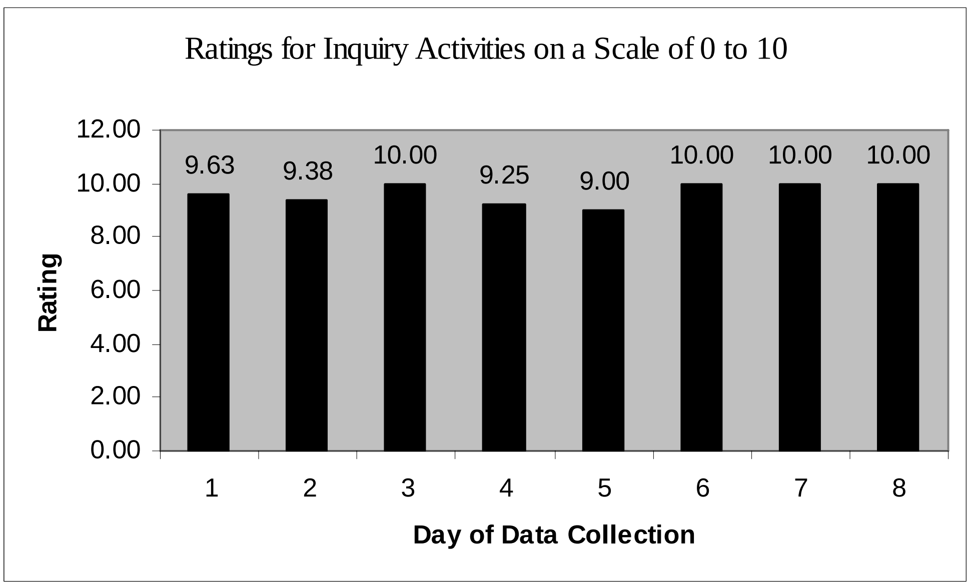


Figure 9: Ratings for Inquiry Activities

In my observations, I noticed that, overall, girls became increasingly comfortable with inquiry learning. This was supported by the increase in active participation and the students' ratings of the lessons in their journals. Figure 9 shows the ratings that students gave to the investigation at the end of each lesson.

The rating results are consistent with my observations and the increase in active-manipulating behaviors and the decrease in passive-assisting behaviors from the beginning to the end of the study. The ratings were higher for the lessons at the end of the study. The students were more actively engaged in their learning at the end of the study, which elicited a stronger appreciation of the inquiry activities.

Likewise, the increase in active engagement in learning with the progression of the study is consistent with the positive change in student attitude towards science discussed in the "inquiry and students' attitudes" section of this chapter. When students are actively engaged and take ownership of their learning, they develop a more positive attitude towards science.

A factor that may have influenced the results in this category is that girls were working in single-gender groups during the study, while they had worked in mixed-gender groups prior to the study. During the interviews, six out of eight participants believed that girls participated more when there were no boys present in their group. Girls may have participated more actively as the study progressed because they became comfortable working in single-gender groups.

Single-Gender Grouping

Research Question #3: What was female students' perception of their participation in single-gender groups?

Prior to the study, students worked in mixed gender groups for all subjects including science. During the four weeks of the study, students worked in mixed gender groups for all subjects, except for science, where students were assigned to single-gender groups A and B . Interviews were conducted at the beginning and at the end of the study to inquire about female students' perceptions on participation in single-gender and mixed-gender grouping. Interview responses for questions 1 and 6 were examined by comparing the pre interview answers with post interview answers. The results were used to describe female students' perception of girls' group participation.

As shown in table 16, during the pre interviews, six of the eight girls interviewed stated that girls participated more when there were no boys in their group.

Table 16: Pre Interview Results for Single-Gender Grouping and Participation

Question: Do you think girls participate more when there are no boys in their group?

Student	Pre Interview Response
Ann	Yes
Jennifer	No
Leah	Yes
Mary	Yes
Pam	Yes
Rebecca	Yes
Sarah	No
Tara	Yes

Jennifer and Sarah disagreed that girls participated more in single-gender groups because they believed that boys and girls cooperated equally in group work. Pam believed that "…boys get to do the stuff sometimes …They like to tell you what to do and do the stuff." Tara and Ann shared that boys tended to act out more, leading girls to participate less. Rebecca said that girls preferred talking to other girls instead. Mary said she believed that girls participate more in single-gender groups but was unable to give a reason as to why. Leah believed that "some boys are genius and some girls are genius but if [there are] no boys then the girls will have better work than with boys."

Interviews were conducted again at the end of the study to inquire about students' perceptions on single-gender grouping. Table 17 shows the results of the post interviews. As shown in table 17, in the post interviews, six of the girls maintained their position while two girls changed their opinion. Leah, who stated that girls did better work when without boys in their group during the pre interview, believed the opposite at the end of the study. During the post interview, she declared that both girls and boys work hard and "that's why they do [the work] together." Sarah, who believed that girls did not participate more in the absence of boys in their group at the beginning of the study, changed her opinion at the end. Her reasoning was that "sometimes [boys] know answers that girls don't know."

Table 17: Pre and Post Interview Results for Single-Gender Grouping and Participation

Question: Do you think girls participate more when there are no boys in their group?

Student	Pre Interview Response	Post Interview Response
Ann	Yes	Yes
Jennifer	No	No
Leah	Yes	No
Mary	Yes	Yes
Pam	Yes	Yes
Rebecca	Yes	Yes
Sarah	No	Yes
Tara	Yes	Yes

Ann, who at the beginning believed that the cause was boys' tendencies to act out, at the end of the study, added that it was "[because] girls less fight than boys…like argue about who does what." Mary, who was not able to give a reason for her answer during the first interview, explained, in the final interview, that girls participated more when boys were not present "because girls don't really copy boys a lot." In other words, she meant to say that girls did more active work instead of depending on the boys for answers.

In both the pre and post interviews, six out of eight participants believed that girls participated more when there were no boys present in their group. Two students believed that girls participated equally with the presence of boys. These results did not reflect a group change in the participants' perception of girls' participation after working in single-gender grouping.

Even though there was no change, overall, girls' answers marked a strong feeling that girls tend to participate more in single-gender groups. However, when girls were asked during the pre interview if they participated the same as others in their group, without mention of gender (boys) in the question, six out of the eight girls stated that they participated the same and two said they participated more. Also, unlike the former question, this latter question was worded to ask specifically about the student, not about girls in general. An important point here is that students were in mixed gender groups during the pre-interview period. Thus, none of the girls in the study reported participating less than others' in their pre-study groups, which included boys. In the post interview, seven out of the eight girls, replied that they participated the same as other students in the class and one said that she participated more than others. Therefore, none of the girls in the study seemed to have felt that their own participation was less than others' in their groups at the beginning or at the end of the study. I consider it a possibility that girls said they participated the same or more in their groups during both interviews because they may have been reluctant to admit otherwise in front of me, their teacher.

As mentioned in the results discussion for participation, the dynamics for team A and team B were different. Team A members cooperated more equally in their inquiry learning tasks. The personality combination in team B, which included two strong leading group members may have contributed to inequality in participation. I believe that Rebecca and Jennifer's strong leading personalities had an effect in Mary and Sarah's participation scores. The group dynamics in group B are comparable to the inequalities in mixed-gender groups described in the literature review, where boys are dominant and girls feel that their participation is restricted. This has led me to believe that, instead of separating students by gender, perhaps it is best to find strategies that will make the students aware of the need for equality in group work.

Conclusion

In addition to improving students' attitudes towards science, inquiry learning fostered an increase in active student participation. After working in single-gender groups throughout the study, six out of the eight participants perceived that girls participated more in single-gender groups than they did in mixed-gender groups before the study. Chapter five concluded my action research study on the effects of inquiry learning and single-gender grouping on girls' participation and attitudes towards science.

CHAPTER FIVE: CONCLUSION

Research suggests that girls perform better in academic environments where discovery methods, such as inquiry, are applied, as opposed to conventional methods. The level of engagement of the students is an important part of inquiry learning (NRC, 2000). Existing literature suggests that boys tend to dominate in mixed-gender science and mathematics classes and this limits girls' engagement. The objective of this study was to examine the effect of incorporating inquiry learning methods on girls' participation and attitudes towards science. Based on the fore mentioned research, I arranged the classroom so that participating girls worked in single-gender groups and investigated their perceptions and attitudes while in single-gender group before and after the study.

According to the pre and post surveys and the pre and post interviews, girls' attitudes towards science became more positive as a result of their experiences with inquiry learning. Students demonstrated effective active engagement in learning through their journal entries. Female students' confidence in their academic performance may have translated in a more positive attitude towards science. The attitudinal results may be partly related to the observations results, which showed increased active participation within groups. Overall student participation in the active-leading category was rather steady throughout the study. Overall student participation in the active-manipulating category increased as the days of the study progressed. Passive-assisting behaviors decreased as the study progressed. This shows that inquiry learning motivated students to become more active participants in science. These findings corroborate with existing literature which supports inquiry as an effective way to engage girls in meaningful science experiences (Becker &Miles, 1978; El-Haj, 2003; Hammrich, 2002; Strand & Mayfield, 2002).

After working in single-gender groups throughout the study, most students had the perception that girls participated more in single-gender groups than they did in mixed-gender groups. This corroborates with existing research which has concluded that boys tend to control participation in mixed-gender groups because they tend to be more dominant (Campbell & Evans, 1997; Dreves & Jovanovic, 1998; Richardson, Hammrich & Livingston, 2003; Streitmatter, 1997). However, none of the girls in the study seemed to have felt that their own participation was less than others' in their groups. This was evidenced by their responses in both the pre interview, when girls were still in mixed-gender groups, and the post interview, after participation in single-gender groups.

A situation that emerged during the study was the inequality in participation among the girls in one of the two single-gender groups. Two dominant girls limited the participation of the other two group members. I find it to be comparable to the inequality in mixed-gender groups found in previous research (Campbell & Evans, 1997; Dreves & Jovanovic, 1998; Richardson, Hammrich & Livingston, 2003; Streitmatter, 1997), where boys are dominant and girls feel that their participation is restricted.

Furthermore, I observed that the girl in my class who worked in a team with two boys because she did not have permission to videotape dominated her group. The situation was very extreme because she made the boys become frustrated in several occasions and my intervention was necessary. These results and observations on gender interaction have led me to believe that, when it comes to participation, teachers should help all students interact equally.

Implications

Participating in action research allowed me to study my students closely and objectively. The project led to reflect on my role as a teacher to deliver instruction in a manner that is effective, engaging, and comfortable. I believe that reflection in my teaching practice is important because it helps me pinpoint the individual needs of my students.

During the research, I got to observe how my students got increasingly involved and interested in their science lessons through the use of inquiry learning. Although my research was focused on the girls in the classroom, I noticed that the boys also worked avidly on their discoveries. I observed the students' excitement when they found out something new and when they were able to make connections with different scientific concepts. The results of this project have strengthened my resolve to continue to use inquiry methods in science teaching to meet my students' needs. I also will keep in mind that some students need more teacher involvement and direct instruction, such as Leah's case. Leah was actively participating in inquiry lessons but I think she needed additional help like individual instruction to help her understand the content.

As a result of this study, I will continue to use journals during science class. The use of journals and class ratings during the study was helpful to me because I did not have to wait to give a test to be aware of my students' progress and understanding.

Ratings of the lessons will also be helpful tools for me in the future to evaluate if I am selecting curriculum that will maintain my students' interest.

Although girls had the perception that girls participated more in single-gender groups than they did in mixed-gender groups, none of the them reported that their own participation was less than others' in the mixed-gender groups they had worked with before the study. This, and the inequality in participation I observed in group B, has led me to believe that, instead of separating students by gender, perhaps I need to look into finding character education interventions to help students participate equally regardless of the group's gender or personality make-up.

Limitations

The conclusions reported here apply only to this action research. Generalizations cannot be made outside of this study.

One of the limitations of this study may have been the small number of participants. There were 15 students in my class, of which only 9 were girls. One of the female students did not have parental permission to be videotaped. I placed her in a cooperative group with two boys to allow her to participate in class without being recorded. Since my action research focused on girls' participation in single-gender grouping, and videotaping was essential to check accuracy of results, data was analyzed only for 8 females.

The school where the study took place is located in a suburban community with a reduced and free lunch percentage of 14. The State of Florida grades all schools yearly based on the students' achievement in math, reading, and writing standardized tests

(FLDOE, 2005). The students in my school perform high in standardized tests which has earned the school a grade of “A,” the highest that can be achieved in the state’s school grading system. The results of the pre surveys and pre interviews may have been positive in attitude because of the quality of the school. Results in these measures may be different for schools in different settings and with lower achievement.

Another limitation was the short period of time for the gathering of data. The quantitative data from the surveys and the observation tallies were produced with very limited data in duration of the study, non-diverse sample, and sample size.

Due to the small sample size, I did not have control groups for girls’ perceptions of female participation in single-gender groups and mixed-gender groups. Therefore, I relied on the experiences in mixed-gender groping which they had before the study for my discussion on their perceptions of grouping strategies. The unavailability of a mixed-gender control group limits my conclusions on girls’ attitudes and participation with inquiry-based methods since it cannot be verified if the results were affected by the single-gender groups.

Recommendations

For future research, I would recommend carrying out this study with mixed-gender control groups during a longer period of time. Also, I would recommend the inclusion of other instruments such as surveys to study the issue of gender interaction.

The inequalities in participation in group B are comparable to the inequalities in mixed-gender groups found in previous research (Campbell & Evans, 1997; Dreves & Jovanovic, 1998; Richardson, Hammrich & Livingston, 2003; Streitmatter, 1997), where boys are dominant and girls feel that their participation is restricted. For future studies, instead of just separating students by gender, I recommend that focus should also be placed into finding strategies to help students in mixed-gender or “mixed-personality” groups participate equally. One possible venue is the use of focus groups to make students aware of the implications of inequality.

Summary

“If educators and policy-makers are serious about promoting equity, we must identify effective practices and build theoretical and practical accounts of their effectiveness based in real world settings with diverse groups of students and their teachers” (Fradd & Lee, 1999, p. 19). Through my action research, I was able to examine the positive effects of using inquiry methods on girls’ attitudes and participation in science class. Besides improving students’ attitudes towards science, students showed an increase in active participation in cooperative groups. In addition, I studied girls’ perceptions of participation in single-gender groups. Female participants perceived that girls participated more while working in single-gender groups. However, girls’ reports showed no perceived increase in their own group participation as a result of working in single-gender groups instead of mixed-gender groups.

As a result of my study, I will continue to use inquiry in science class. Besides the student benefits, I found that following inquiry-learning methods helped me organize my instruction more effectively. Additionally, I observed that group dynamics may have an effect in students’ science experiences, which has led me to develop an interest in discussing perceptions on group participation openly with all my students. My recommendation to other educators who read this research is that they implement inquiry-learning methods in their science classrooms and that they continue to explore ways to bring gender equity into science education.

APPENDIX A: ATTITUDE SURVEY

Student Survey

Name ______________________________

Read each statement and circle the appropriate response.

SA: strongly agree A: agree D: disagree SD: strongly disagree N: no opinion

1.	Learning is boring.	SA A D SD N
2.	I learn best by reading chapters and answering questions.	SA A D SD N
3.	As I learn, it is important to think about my thinking.	SA A D SD N
4.	I learn more if I have a choice about what I will be learning.	SA A D SD N
5.	When I talk things over with my partner I understand more about what I am learning.	SA A D SD N
6.	I learn more when I work in a group and share ideas.	SA A D SD N
7.	Discovering answers to my own questions is interesting.	SA A D SD N
8.	The best way to measure learning is for my teacher to give tests.	SA A D SD N
9.	My teacher can measure my learning by reading my journal.	SA A D SD N
10.	I like to discuss what I have discovered.	SA A D SD N
11.	Learning is finding out about things that interest me.	SA A D SD N
12.	Learning about science is only important for kids who want to become scientists.	SA A D SD N
13.	I am a scientist.	SA A D SD N
14.	I enjoy reading science picture books.	SA A D SD N
15.	A scientist asks questions.	SA A D SD N
16.	Science textbooks are the best books to read to learn about science.	SA A D SD N
17.	Scientists should answer old questions before asking new ones.	SA A D SD N
18.	I can learn more by reading than by doing.	SA A D SD N
19.	Facts I discover on my own are more memorable than facts someone tells me.	SA A D SD N
20.	Reading, math, and social studies are all parts of science.	SA A D SD N

21. What do you think science really is? (use the back for more space)

APPENDIX B: SCIENCE DISCOVERY LOG

Science Discovery Log

Activity ____________________ Names ____________ ____________

Date __________ ____________ ____________

What question did you try to answer?

Explain what you did to answer your question.

Make a sketch of your experiment.

What did you discover today?

What new question are you curious about for another time?

Are you pleased with your results today? YES ___ NO ___ NOT SURE ___

How would your group rate this activity? Great 10 9 8 7 6 5 4 3 2 1 0 Terrible

APPENDIX C: INTERVIEW QUESTIONS

Student Interview Questions:

1. How much do you participate in your science group work? The same as other students, more than the other students, or less than the other students in class? Why?

2. Does it help you to understand what you are learning when you talk things over with other students in your group? How?

3. Do you think you learn more when you work in a group and share your ideas? Why?

4. Do you like to discuss what you have learned or discovered with the members of your group? Why?

5. Does everyone in your group participate? Tell me more about it.

____

____

____

____

____

____

6. Do you think girls participate more when there are no boys in their group? Why?

____

____

____

7. What did you like more, doing science work and experiments from the textbooks, or doing the inquiry experiments? Why?

____

____

____

8. Do you participate more when we do science work and experiments from the textbooks, or when we do inquiry learning? Why?

____

____

____

APPENDIX D: OBSERVATION TABLE

Table for Observation of Student Participation in this Study:

Level of Participation	Sums of Scores
Active-leading directing suggesting explaining	_____
Active-manipulating. manipulating record keeping reading directions	_____
Passive-assisting assisting following observing	_____

Categorization of Performance Behaviors in Jovanovic & King (1998) and Dreves & Jovanovic (1998):

<u>Active Leading:</u>
Directing
On task
Explaining
Working interactively
Observing
<u>Passive-Assisting:</u>
Assisting
Following
Record Keeping
<u>Active-Manipulating:</u>
Manipulating
Suggesting
Reading directions

APPENDIX E: IRB APPROVAL

THE UNIVERSITY OF CENTRAL FLORIDA
INSTITUTIONAL REVIEW BOARD (IRB)

IRB Committee Approval Form

PRINCIPAL INVESTIGATOR(S): Elsy Estrada; Bobby Jeanpierre, Ph.D. (Supervisor) **IRB #: 05-2766**

PROJECT TITLE: The Effects of Single-Gender Grouping and Inquiry in Second Grade Girls

[X] New project submission
[ ] Resubmission of lapsed project #_____
[ ] Continuing review of lapsed project #_____
[ ] Continuing review of #
[ ] Study expires _______
[ ] Initial submission was approved by expedited review
[ ] Initial submission was approved by full board review but continuing review can be expedited
[ ] Suspension of enrollment email sent to PI, entered on spreadsheet, administration notified ______

Chair
[X] Expedited Approval
Dated: 10 August 2005
Cite how qualifies for expedited review: minimal risk and #7

IRB Co-Chairs:
Signed: Sophia F. Dziegielewski
Dr. Sophia Dziegielewski

[ ] Exempt
Dated: ___________
Cite how qualifies for exempt status: minimal risk and ________________

Signed: ________________________________
Dr. Jacqueline Byers

[X] Expiration
Date: 9 August 2006

Complete reverse side of expedited or exempt form
[ ] Waiver of documentation of consent approved
[ ] Waiver of consent approved
[ ] Waiver of HIPAA Authorization approved

NOTES FROM IRB CHAIR (IF APPLICABLE): First review, minor clarifications needed, see attached.
8/7/2005 SDziegielewski

APPENDIX F: APPROVAL TO USE OBSERVATION MEASURES

Elsy Estrada
12128 Rotuma Street
Orlando, FL 32837

RE: Permission for research

Jasna Jovanovic
University of Illinois
Urbana-Champaign

Dear Ms. Jovanovic,

I am a graduate student at the University of Central Florida. I am working to obtain my Master's degree in math and science education through the Lockheed Martin/UCF Academy for Math and Science. I will be performing an action research thesis based on data collected from my second grade class in the 2005-2006 school year. The purpose of the research is to study the students' levels of participation during cooperative learning inquiry activities. The title of my project will be "The Effects of Gender-Grouping and Inquiry Learning on Second Grade Female Students." My advisor's name is Dr. B. Jeanpierre. All data collected will be used solely for the purpose of the thesis document.

I would like to request your help in obtaining more information (full description) and permission to use the Observation Methods (Scale) you used in the following study: Dreves, C., & Jovanovic, J. (1998). Male dominance in the classroom: Does it explain the gender difference in young adolescents' science ability perceptions?

Title, authors, publisher, and date of copyright will be cited in the reference section. A copy of the methods used in the above mentioned research paper will be included in the appendix with your permission. All data gathered will be used solely for this thesis research. If you agree to the use of the above material in my thesis research, please e-mail back and sign below. I will incurr any postage expenses. Please contact me at (407)251-5452 with any questions or concerns. Thank you for your consideration.

Sincerely,

Elsy Estrada

Permission granted:

Signature Printed Name: Jasna Jovanovic

Title: Associate Professor

APPENDIX G: ATTITUDE SURVEY AND DISCOVERY LOG APPROVAL

Elsy Estrada
12128 Rotuma Street
Orlando, FL 32837

Re: Permission to use figures in:
Pearce, C. (1999). Nurturing inquiry: Real science for the elementary classroom. Portsmouth, New Hampshire: Heinemann.

June 29, 2005

To Whom It May Concern:

I am a graduate student at the University of Central Florida. I am working to obtain my Master's degree in math and science education through the Lockheed Martin/ UCF Academy for Math and Science. I will be performing an action research thesis based on data collected from my second grade class in the 2005-2006 school year. The purpose of the research is to study the students' levels of participation during cooperative learning inquiry activities. The Title of my project will be "The Effects of Gender-Grouping and Inquiry Learning on Second Grade Female Students." My advisor's name is Dr. B. Jeanpierre. All data collected will be used solely for the purpose of the thesis document.

I would like to request your permission to use the following from the above mentioned book:

- Figure 2.1 Student Survey on page 10 – to observe if differences in attitudes towards science occur pre, mid, and post research.
- Figure 4.3 Discovery Box Log Page on page 37 – to record academic performance in each lesson.

Title, author, publisher, and date of copyright will be cited in the reference section. A copy of the figures will be included in the appendix with your permission. All data gathered will be used solely for this thesis research. If you agree to the use of the above material in my thesis research, please sign below. Please contact me at (407) 251-5452 with any questions or concerns. Thank you for your consideration.

Sincerely,

Elsy Estrada

Permission granted:
Brita Mess
Signature

Brita Mess 07/11/05
Printed Name

Permissions Assistant
Title

APPENDIX H: PRINCIPAL APPROVAL LETTER

Bay Meadows Elementary School

"A Five Star School"
"Winner of the Florida School Recognition Award"
9150 Apopka Vineland Road
Orlando, FL 32836

"Where Koala-ty is the Key"

(407) 876-7500
(407) 876-7509 FAX

Dr. Diane Gullett, Principal *Mr. Christopher Daniels, Assistant Principal*

June 7, 2005

To Whom It May Concern:

I, Dr. Diane Gullett, am aware that Ms. Elsy Estrada will be performing an action research thesis based on data collected from her class in the 2005-2006 school year. I give her my permission to collect data on her students' group participation in science class. In addition, I understand that the purpose of the study is to investigate and compare the effects of gender on active participation during cooperative learning inquiry activities.

I am aware that she is obtaining her Master's degree in Math and Science Education through the Lockheed Martin/ UCF Academy for Math and Science and understand that all data collected will be used solely for the purpose of her thesis document. Please contact me at (407) 876-7500 with any questions or concerns.

Sincerely,

Diane Gullett

Dr. Diane Gullett
Principal
Bay Meadows Elementary School

APPENDIX I: PARENTAL CONSENT

Bay Meadows Elementary School

"A Five Star School"

"Winner of the Florida School Recognition Award"

"Where Koala-ty is the Key"

8301 Buena Vista Woods Blvd.

Orlando, FL 32836

(407) 876-7500

(407) 876-7509 Fax

www.ebm.ocps.net

Dr. Diane Gullett
Principal

Mr. Christopher Daniels
Assistant Principal

August 2005

Dear Parent:

I am currently a graduate student in the Lockheed Martin/University of Central Florida Science and Mathematics K-8 Master's Program under the supervision of faculty member Dr. Bobby Jeanpierre. I am conducting research on student participation in the elementary science classroom. As a graduation requirement, I will conduct an action research project and document the findings in a thesis. Dr. Gullett, our principal, is aware of this action research study.

The focus of this research is to look into the effects gender has on student participation and performance in the elementary science classroom. The frequency and type of participation – active-leading, active-assisting, or passive assisting – of students will be recorded. Data will be gathered through observation during science classes. Video and audio tape recording will be used during science classes during the study for observation and data recording purposes. The data will not be disclosed to anyone except my supervising professor and me. At the conclusion of the study, all documents, videotapes, and audio tapes will be destroyed.

I would like to include all of my students in this research opportunity. Therefore, I am requesting your permission for your student's participation. The activities in the study are the usual activities required for general classroom instruction. Students who choose to not participate will be engaged in the same classroom activities but no data will be gathered about them for the study. If you choose to have your child participate, please check yes on the blank space below and return the signed portion of this form by 9/16/05. If you choose not to have your child participate, check no in the place provided.

There is no penalty of any kind for those students who do not participate. You and your child have the right to withdraw consent for your child's participation at any time without consequence. There are no known risks or immediate benefits to the participants. No compensation is offered for participation.

If you have any questions about this research study, please contact me at (407) 876-7500, or my faculty supervisor, Dr. B. Jeanpierre at (407) 823-4930. Questions or concerns about research participants' rights may be directed to the UCFIRB Office, University of Central Florida Office of Research, Orlando Tech Center, 12443 Research Parkway, Suite 302, Orlando, FL 32826. The phone number is (407) 823-2901.

Sincerely,

Ms. Elsy Estrada

Elsy Estrada
Second Grade Teacher
Bay Meadows Elementary School

I have read the procedure described above. I voluntarily agree to participate in the procedure, and I have received a copy of this description.

I, ____________________________ have read and understand the letter for participation in "The Effects of Single-Gender Grouping and Inquiry in Second Grade Girls" research study.

____________________ ________________
Parent's signature Date
_____ Yes, I give permission to my child to participate.

____________________ ________________
Parent's signature Date
_____ No, I do not want my child to participate.

I, ____________________________ have read and understand the letter for participation in "The Effects of Single-Gender Grouping and Inquiry in Second Grade Girls" research study. I understand the teacher-researcher may videotape some science activities and the tapes will be destroyed at the completion of the study.

____________________ ________________
Parent's signature Date
_____ Yes, I give permission to my child to be videotaped during the project.

____________________ ________________
Parent's signature Date
_____ No, I do not want my child videotaped during the project.

I, ____________________________ have read and understand the letter for participation in "The Effects of Single-Gender Grouping and Inquiry in Second Grade Girls" research study. I understand the teacher-researcher may audiotape some science activities and the tapes will be destroyed at the completion of the study.

____________________ ________________
Parent's signature Date
_____ Yes, I give permission to my child to be audio taped during the study.

____________________ ________________
Parent's signature Date
_____ No, I do not want my child to be audio taped during the study.

APPENDIX J: STUDENT ASSENT SCRIPT

Student Assent Form

My name is Elsy Estrada and I am a student at the University of Central Florida. I would like to ask you to participate in my study. Your participation is strictly voluntary and whether or not you participate in the study will not affect your grade. During the study I will ask questions about the lessons we are studying, and I will video and audio tape some of the sessions. You may stop at any time and do not have to answer any questions you do not want to answer. Would you like to participate in my study?

LIST OF REFERENCES

American Association of University Women. (1992). *Shortchanging girls, shortchanging America: A call to action.* Washington, DC: AAUW Initiative for Educational Equity.

Atwater, M. (1996). Social constructivism: Infusion into the multicultural science education research agenda. *Journal of Research in Science Teaching*, 33 (8), 821-837.

Becker, W., & Miles, C. (1978). Interpersonal competition and cooperation as a function of sex of subject and sex of counterpart. *The Journal of Social Psychology*, 104, 303-304.

Caine, G., Caine, R., & McClintic, C. (2002). Guiding the innate constructivist. *Educational Leadership*, 60(1), 70-73.

Campbell, K., & Evans, C. (1997). Gender issues in the classroom: A comparison of mathematics anxiety. *Education*, 117 (3), 332-339.

Dewey, J. (1916). *Democracy and education*. Retrieved October 29, 2005, from Columbia University, Institute for Learning Technologies Web site: http://www.ilt.columbia.edu/publications/dewey.html

Dreves, C., & Jovanovic, J. (1998). Male dominance in the classroom: Does it explain the gender difference in young adolescents' science ability perceptions? *Applied Developmental Science*, 2 (2), 90-98.

El-Haj, T. (2003). Challenging the inevitability of difference: Young women and discourses about gender equity in the classroom. *Curriculum Inquiry,* 33 (4), 401-425.

Florida Department of Education (2005). *2004-2005 School Accountability Report Guide Sheet*. Retrieved April 8, 2006, from Florida Department of Education Web site: http://firn.edu/doe/schoolgrades/guide05.htm

Fradd, S., & Lee, O. (1999, August/September) Teachers' roles in promoting science inquiry with students from diverse language backgrounds. *Educational Researcher*, 28(6), 14-20.

Green, S., & Gredler, M. (2002). A review and analysis of constructivism for school-based practice. *School Psychology Review*, 31(1), 53-70.

Hammrich, P. (2002). Gender equity in science and mathematics education: Barriers of the mind. In Koch, J. & Irby, B. (Eds.). *Defining and redefining gender equity in education* (pp. 81-98). Greenwich, CT: Information Age Publishing, Inc.

Jaworski, B. (1996). Constructivism and teaching – the socio-cultural context. Retrieved October 11, 2004, from Barbara Jaworski's Web site: http://www.grout.demon.co.uk/Barbara/chreods.htm

Jeanpierre, B. (2003). Inquiry teaching: where to begin. *The Florida Science Teacher,* 15(2), 7-10 &31.

Jovanovic, J. & King, S. S. (1998). Boys and girls in the performance-based science classroom: Who's doing the performing? *American Educational Research Journal*, 35(3), 477-496.

Kamii, C., & Ewing, J. (1996). Basing technique on Piaget's constructivism. *Childhood Education*, 72(5), 260-264.

Keegan, M. (1993, April). Optimizing the instructional moment: A guide to using socratic, didactic, inquiry, and discovery methods. *Educational Technology Magazine*, 33(4), 17-22.

Kelly, C. (1999). Gender and inquiry: an investigation into identifying and defining the role of inquiry in higher-order thinking. *European Journal of Teacher Education*, 22 (1), 101-114.

Klahr, D., & Nigam, M. (2004). The equivalence of learning paths in early science instruction: Effects of direct instruction and discovery learning. *Psychological Science*, 15(10), 661-667.

Kobella, Jr., T. (1989). Changing and measuring attitudes in the science classroom. *Research Matters* (8901). Retrieved March 13, 2006, from National Association for Research in Science Teaching Web site: www.educ.sfu.ca/narstsite/

Lee, H., & Songer, N. (2003). Making authentic science accessible to students. *International Journal of Science Education*, 25(8), 923-948.

Mills, G.E. (2003). *Action Research*. Upper Saddle River, NJ: Pearson Education.

National Research Council (1996). *National science education standards.* Washington, DC: National Academies Press.

National Research Council (2000). *Inquiry and the national science education standards*. Washington, DC: National Academies Press.

National Science Foundation (2000). *Report of the congressional commission on the advancement of women and minorities in science, engineering and technology development.* Retrieved December 27, 2005, from National Science Foundation Website: http://www.nsf.gov/pubs/2000/cawmset0409/cawmset_0409.pdf

Palincsar, A., Collins, K., Marano, N., & Magnusson, S. (2000). Investigating the engagement and learning of students with learning disabilities in guided inquiry science teaching. *Language, Speech, and Hearing Services in Schools*, 31 (3), 240-251.

Pearce, C.R. (1999). *Nurturing Inquiry*. Portsmouth, NH: Heinemann.

Phillips, D. (1995). The good, the bad, and the ugly: the many faces of constructivism. *Educational Researcher*, 24(7), 5-12.

Post, P., & Williams, M. (1996). Career and lifestyle expectations of rural eighth-grade students: A second look. *Career Development Quarterly*, 44 (3), 250-257.

Richardson, G., Hammrich, P., & Livingston, B. (2003). Improving elementary school girls' attitudes, perception, and achievement in science and mathematics: Hindsights and new visions of the sisters in science program as an equity reform model. *Journal of Women & Minorities in Science & Engineering*, 9 (3/4), 333-348.

Richardson, J. (1995, May/June). Separated by sex. *Teacher Magazine,* 6(8), 14-15.

Schmidt, P., Gillen, S., Zollo, T., & Stone, R. (2002). Literacy learning and scientific inquiry: children respond. *Reading Teacher*, 44 (6), 534-550.

Spencer, R., Porche, M., & Tolman, D. (2003). We've come a long way – maybe: New challenges for gender equity in education. *Teachers College Record*, 105(9), 1774-1807.

Stocking, V., & Goldstein, D. (1992). Course selection and performance of very high ability students: Is there a gender gap? Research. *Roeper Review*, 15 (1), 48-51.

Strand, K., & Mayfield, M. E. (2002). Pedagogical reform and college women's persistence in mathematics. *Journal of Women and Minorities in Science and Engineering*, 8, 67-83.

Streitmatter, J. (1997). An exploratory study of risk-taking and attitudes in a girls-only middle school math class. *The Elementary School Journal*, 98 (1), 15-26.

Tamir, P., Stavy, R., & Ratner, N. (1998). Teaching science by inquiry: assessment and learning. *Journal of Biological Education*, 33 (1), 27-33.

Tocci, C., & Engelhard, G. (1991). Achievement, parental support, and gender differences in attitudes toward mathematics. *Journal of Educational Research*, 84 (5), 28-34.

Von Glasersfeld, E. (1989). *An exposition of constructivism: Why some like it radical*. Amherst, MA: University of Massachusetts monograph, Scientific Reasoning Research Institute.

Von Secker, C. (2002). Effects of inquiry-based teacher practices on science excellence and equity. *The Journal of Educational Research*, 95 (3), 151-160.

Wright, E., & Govindarajan, G. (1995). Discrepant event demonstrations: motivating students to learn science concepts. *The Science Teacher*, 62 (1), 24-28.

Zuckerman, G., Chudinova, E, & Khavkin, E. (1998). Inquiry as a pivotal element of knowledge acquisition within the Vygotskian paradigm: building a science curriculum for the elementary school. *Cognition and Instruction*, 16 (2), 201-233.